

# MASTER QUALITY ASSURANCE PROJECT PLAN

Of The  
Hazardous Waste Remediation Bureau  
Waste Management Division  
New Hampshire Department of Environmental Services

This document serves as the QAPP for all sites being investigated and/or remediated through contracts administered by the HWRB and any sampling by HWRB staff.

**EQA RFA# 08036**



**Prepared By:**  
Sharon G. Perkins  
QA Coordinator  
Hazardous Waste Remediation Bureau  
Waste Management Division  
New Hampshire Department of Environmental Services  
29 Hazen Drive  
Concord, N.H. 03301  
Phone: (603) 271-6805  
E-mail: SharonPerkins@des.nh.gov

Approved November 2007  
Revision #2, January 2009

### TITLE AND APPROVAL PAGE

Master Quality Assurance Project Plan of the Hazardous Waste Remediation Bureau,  
Waste Management Division, New Hampshire Department of Environmental Services,  
September 2007, EQA RFA# 08036

This document serves as the QAPP for all sites being investigated and/or remediated through  
contracts administered by the HWRB and any sampling by HWRB staff.

Sharon G. Perkins  
NHDES HWRB Quality Assurance Coordinator

Signature: Sharon G. Perkins Date: September 26, 2007

Richard H. Pease, P.E.,  
NHDES HWRB Manager Federal Sites Program

Signature: Richard H. Pease Date: October 2, 2007

John M. Regan, P.G.  
NHDES HWRB Manager State Sites Program

Signature: John M. Regan Date: October 2, 2007

Kenneth N. Kettenring, Ph.D., P.G.  
NHDES HWRB Manager Grants and Contracts

Signature: Kenneth N. Kettenring Date: October 2, 2007

Carl W. Baxter, P.E.  
NHDES HWRB Administrator

Signature: Carl W. Baxter Date: September 27, 2007

Vincent R. Perelli  
NHDES QA Manager

Signature: Vincent R. Perelli Date: October 19, 2007

Steven DiMattei  
QA Chemist, EPA Region 1

Signature: Steven DiMattei Date: 11-07-07

## TABLE OF CONTENTS

TABLE OF CONTENTS.....	1
TABLE OF CONTENTS Continued.....	2
DISTRIBUTION LIST .....	3
LIST OF ACRONYMS .....	4
1.0 INTRODUCTION .....	6
1.1 Overview of the Hazardous Waste Remediation Bureau .....	6
1.2 Project Organization, Responsibilities and Communication Pathways.....	7
1.3 Project Description.....	8
1.4 Quality Assurance Objectives.....	8
1.5 Training, Personal Protection and Safety.....	10
1.6 Documentation and Records .....	10
1.6.1 Documentation of Field Activities .....	10
1.6.2 Technical Reports of Field Activities.....	11
Quality Assurance/Quality Control Section of Report .....	12
1.6.3 Document Handling and Retention Times .....	12
1.6.4 Sample Numbering System for the NHDES Lab.....	13
1.7 Data Assessment .....	14
1.8 Corrective Action.....	15
2.0 MONITORING AND SAMPLING PROCEDURES.....	16
2.1 Generic Sampling Strategies and Procedures .....	16
2.2 Sampling Equipment.....	17
2.3 Decontamination .....	17
2.4 Instrument Calibration and Maintenance.....	18
2.5 Field Screening Instruments .....	19
2.6 Laboratory Services .....	20
2.7 Sample Volume, Containers and Labeling .....	20
2.8 Sampling Preservation and Holding Times .....	21
2.9 Chain of Custody and Sample Delivery Procedures.....	21
2.10 Laboratory Sample Management.....	22
2.11 Sample Quality Control .....	22
3.0 REFERENCES .....	25
A. Program Organization and Responsibilities, Organizational Chart	
B. Sampling Equipment / Field Equipment	
C. Standard Operating Procedures	
D. NHDES Laboratory's Chain of Custody Form	
E. Well Sampling Worksheet	
F. Example - SAP Outline	

**TABLE OF CONTENTS Continued**

- G. Example Table - Site Analytes, Regulatory Standards and Lab Criteria
- H. Example Table – Media and Laboratory Requirements (Media, Analysis, Test Methods, Containers/Sample Volume, Preservation & Hold Time)
- I. Example Table - Summary of Quality Assurance Samples
- J. HWRB Records Retention Policy
- K. Crosswalk between Master HWRB QAPP and EPA Requirements
- L. QAPP Personnel Log Sheet  
(Found only in the original QAPP that is kept with the QA Coordinator)

## **DISTRIBUTION LIST**

Upon approval and implementation of this Master Quality Assurance Project Plan (QAPP) for the Hazardous Waste Remediation Bureau (HWRB), the original shall be kept with the HWRB Quality Assurance (QA) Coordinator; with a copy placed with the New Hampshire Department of Environmental Services (NHDES) QA Manager.

The current official version of the Master HWRB QAPP will be available on the NHDES Website at:

[http://des.nh.gov/organization/divisions/waste/hwrp/documents/hwrp\\_master\\_qapp.pdf](http://des.nh.gov/organization/divisions/waste/hwrp/documents/hwrp_master_qapp.pdf) .

Other links may be provided as seems appropriate.

The following people will be notified of the location of the official (most current) version of the Master HWRB QAPP by email:

- All HWRB Personnel
- The contact person for each contractor approved by NHDES to perform work for the HWRB

## LIST OF ACRONYMS

ASTM	American Society for Testing Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CGI	Combustible Gas and Oxygen Detector
COC	Chain of Custody
COPC	Contaminant of Potential Concern
DOD	Department of Defense
DQO	Data Quality Objectives
EHP	Environmental Health Program
ELAP	Environmental Laboratory Accreditation Program
EMD	Environmental Monitoring Database
EPA	Environmental Protection Agency
FID	Flame ionization detector
FSS	Federal Sites Section of the Hazardous Waste Remediation Bureau
GMZ	Groundwater Management Zone
HASP	Health and Safety Plan
HWRB	Hazardous Waste Remediation Bureau
ID	Inside Diameter
LFS	Low Flow Sampling
MDL	Method Detection Limits
NAPL	Non-Aqueous Phase Liquid
NCP	National Contingency Plan
NHDES	New Hampshire Department of Environmental Services
NHDES Lab	NHDES Laboratory Services Unit
NIST	National Institute of Standards & Technology
NELAC	National Environmental Laboratory Accreditation Conference
NELAP	National Environmental Laboratory Accreditation Program
NPL	National Priorities List
NTU	Nephelometric Turbidity Units
OD	Outside Diameter
ORCB	Oil Remediation & Compliance Bureau
ORP	Oxygen Reduction Potential
OSHA	Occupational Safety and Health Administration
PEHB	Permitting & Environmental Health Bureau
PIC	Public Information Center
PID	Photoionization Detector
PM	Project Manager
POE	Point of Entry
PQO	Project Quality Objectives
PRP	Potentially Responsible Party
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control

**LIST OF ACRONYMS – Continued**

QAC	Quality Assurance Coordinator
QAM	Quality Assurance Manager
QAPP	Quality Assurance Project Plan
QC	Quality Control
QMP	Quality Management Plan
QSM	Quality Systems Manual
RDL	Reporting Detection Limits
RI/FS	Remedial Investigation and Feasibility Study
RPM	Remedial Project Manager
SAP	Sampling and Analysis Plan
SARA	Superfund Amendments and Reauthorization Act
SOP	Standard Operating Procedure
SRP	Site Remediation Program
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds
WMD	Waste Management Division

## **1.0 INTRODUCTION**

This generic Master Quality Assurance Project Plan (QAPP) has been prepared to ensure that all sample collection and data generation activities associated with the HWRB yield data that are of adequate quality for their intended use. This document serves as the QAPP for all sites being investigated and/or remediated through contracts administered by the HWRB and any sampling by HWRB staff. (The section on Data Assessment may also be useful for Project Managers administering sites being addressed by responsible parties.) This QAPP does not cover sites which are contaminated primarily with petroleum products and administered by the Oil Remediation & Compliance Bureau (ORCB). Nor does it cover any laboratory's quality assurance programs other than in general terms.

This master QAPP is composed of standardized elements covering routine components of a project from planning, through implementation, to assessment. Information not covered in this QAPP will be included in site-specific Sampling and Analysis Plans (SAPs), which will be written as needed. See Appendix F for an example of a SAP outline. These plans will include at a minimum: site maps, sample locations, site specific organizational chart, the number and type of environmental data collection activities; data quality objectives specific to applicable action levels and data quality criterion; data validation, documentation including a quality control section, and any non-routine data collection/measurement activities not included in this Master QAPP; and will be approved by the appropriate Project Manager, with a copy provided to the NHDES QA Manager.

All procedures must be in accordance with applicable professional technical standards; United States Environmental Protection Agency (USEPA) requirements; the New Hampshire Department of Environmental Services Administrative Rules; specific Waste Management Division (WMD) requirements, other applicable government regulations or guidelines; and specific project goals and requirements.

This document replaces the Master Quality Assurance Project Plan of the Hazardous Waste Remediation Bureau (Master HWRB QAPP), EQA RFA# 08036, Revision #1, January 2008.

### **1.1 Overview of the Hazardous Waste Remediation Bureau**

The HWRB deals with releases of hazardous substances and is part of the Site Remediation Program which is responsible for overseeing the cleanup of contaminated sites. The major objective of the HWRB is to investigate and cleanup contaminated sites and return those sites to productive use.

The HWRB is divided into three main sections: a State Sites Program, a Federal Sites Program and a Grants and Contracts Management Unit. The State Sites Program is comprised of a Brownfields section and a Groundwater Remediation Permitting section. The Federal Sites Program is comprised of a Superfund Sites Management section and a Department of Defense Sites section. The Grants and Contracts Management Unit includes a Site Remediation section.

Contractors are procured using standard State of New Hampshire practices as outlined in RSA 21-I:22. For specific sites, contractors are selected by the Program Manager based on their availability,



their skills related to the issues found at the site and the recommendations of the Project Manager. Work-Scopes are typically written by the contractor based on input from the Project Manager and covers what the Project Manager is requiring the contractor to do. SAPs are typically written by the contractor and covers how they are going to do what was required in the Work-Scope. SAPs are typically written when sampling is required. The Project Manager approves Work-Scopes and SAPs, with input from the Quality Assurance Coordinator. See Appendix F for an example of a SAP outline.

## **1.2 Project Organization, Responsibilities and Communication Pathways**

A graphic illustration of the project organization and communication pathways can be found in Appendix A. These are considered to be general pathways of communication and do not restrict communication between all parties, as necessary. The roles and responsibilities are described in greater detail in Appendix A.

- The Quality Assurance Manager (QAM) is the key NHDES individual responsible for quality assurance (QA). The QAM reports to the Commissioner's Office and communicates directly with the QA Coordinator (QAC).
- The QA Coordinator reports to the HWRB Administrator and is the liaison between the QA Manager and all other HWRB personnel. When the NHDES Lab is used, the QA Coordinator is the liaison between the NHDES Laboratory Services Unit (NHDES Lab) and the Project Manager. The QA Coordinator reviews the sampling reports received from the NHDES Lab for quality control.
- The section supervisors report to the HWRB Administrator and interact directly with the Project Managers, the QA Coordinator, the contractor, and EPA.
- The Project Managers report to the section supervisors and coordinate activities with the QA Coordinator, contractor, NHDES Lab, the Environmental Health Program (EHP) for their assessment of possible health effects, and EPA.
- The contractor coordinates activities directly with their staff, the Project Manager, the QA Coordinator, and the appropriate laboratory.
- When the NHDES Lab is used, the Lab reports the analytical results to the QA Coordinator, after having audited the results in accordance with their standard operation procedures (SOPs).
- The Environmental Health Program (EHP) in the Permitting & Environmental Health Bureau (PEHB) reports risk assessment determinations to the appropriate Project Manager and may communicate with QA personnel or the contractor as necessary.
- EPA communicates with the QA personnel, the Administrator, the section supervisors and the Project Managers.

### **1.3 Project Description**

Assessment and remedial activities at hazardous waste sites may include the following:

- Initial Site Assessments (Phase I);
- Historical Phase IA/IB Archaeological Sensitivity Assessments;
- Phase II and III Site Assessments;
- Risk Characterization/Assessment;
- Groundwater Management Zone Permitting;
- Groundwater Permit Monitoring;
- Remedial Action Plan Preparation;
- Bench/Pilot Testing of Proposed Remedial Approach;
- Remedial Action Implementation; and
- Long Term Monitoring.

Site characterization activities involving sampling and analytical testing may include, but not be limited to, the following Phase I and/or Phase II Investigation activities:

- Geophysical Surveys;
- Test Pit Explorations;
- Test Borings/Installation of Monitoring Wells;
- Hydrogeological testing;
- Soil Gas Surveys;
- Soil, Gas, and Groundwater Sampling;
- Surface Water and Sediment Sampling; and
- Vapor intrusion studies.

Each site-specific SAP shall include a description of the anticipated tasks based on the NHDES approved Work-Scope for that project. See Appendix F for an example of a SAP outline.

In general, the contaminants of concern are volatile organic compounds (VOCs), semi-volatiles and metals. Other contaminants shall be investigated as appropriate.

### **1.4 Quality Assurance Objectives**

The primary QA objective for all projects is to assure that all measurements are representative of actual site conditions and that all data resulting from field, sampling, and analytical activities be comparable and generated in a scientifically valid and legally defensible manner. It is important that the data collected are of known and documented quality. Any party generating data under this program has the responsibility to implement minimum procedures to assure that the precision, accuracy, completeness, and representativeness of its data are known and documented. The use of accepted, published sampling and analysis methods, as well as the use of standardized units, aid in ensuring the comparability of the data. The standard operating procedures (SOPs), as included in Appendix C of this project plan, have been developed to meet this objective.

Data quality objectives (DQOs) are qualitative or quantitative statements developed by the data user to specify the quality of the data needed from a particular activity to support specific

decisions. The DQOs are the starting point in designing a sampling program. The DQO development process matches sampling and analytical capabilities to the data targeted for specific uses and ensures that the quality of the data meets project requirements. Specific DQOs will be discussed in the site-specific SAPs as they are unique to each project.

General DQOs include the following:

- To evaluate the risk to human health and the environment, (*i.e.* detection limits must be sufficiently low to compare to the regulation or statute that governs the sampled media);
- To establish long term trends in contaminant levels to support future site management decisions; and
- To evaluate the effectiveness of a treatment system or other remedial strategy.

In general, the objectives of long-term environmental monitoring are to monitor the effectiveness of the remedial action in achieving risk reduction.

Long-term groundwater monitoring is a component of the remedial alternatives selected for many sites. The project quality objectives (PQOs) for long-term groundwater monitoring are to evaluate the concentrations of contaminants of potential concern (COPC) and natural attenuation processes in groundwater to:

- Verify that groundwater containing COPCs in excess of the remediation goal concentrations do not migrate past the Groundwater Management Zone (GMZ) Compliance boundaries;
- Verify reductions in COPC concentrations, on-going natural attenuation processes for the plumes in which the monitoring natural attenuation alternative has been selected, and plume attenuation rates;
- Determine if the remedial alternatives are operating properly and successfully; and
- Determine when groundwater concentrations no longer exceed criteria protective of human health.

The HWRB will accept the limits of precision and accuracy for analytes that have been established by the QA Officer of the NHDES Lab. The NHDES Lab's Limits of Precision and Accuracy is a support document found in the Lab's Quality Systems Manual. In general, the HWRB will accept the Method Detection Limits (MDL) and the Reporting Detection Limits (RDL) established by the NHDES Lab, however, the Project Managers may request alternate limits to meet their quality objectives. Alternate limits requested by Project Managers will be documented in the SAP.

When outside laboratories are used it is the Project Manager's responsibility to ensure that the laboratory's quality assurance program, including the Lab's MDL's, RDL's and limits of precision and accuracy for any quality control sample, support their DQOs and PQOs.

Each SAP shall contain a summary table of analytical test methods, laboratory RDLs/ MDLs and regulatory action limits for all compounds tested on site. See Appendix G: Example Table - Site Analytes, Regulatory Standards and Lab Criteria.

## **1.5 Training, Personal Protection and Safety**

Personnel shall have received training in accordance with Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120 (e) including annual refresher courses. All training shall be documented. Training records shall be maintained by the employer of the staff and be available upon request. Standard safety practices shall be employed, and appropriate protective clothing shall be worn during all site visits.

Appropriate and effective health and safety practices shall be integrated into all daily operations to promote safe and healthful working conditions. At minimum procedures shall comply with OSHA and other applicable local, State, and federal laws and regulations.

## **1.6 Documentation and Records**

Upon approval and implementation of this Master QAPP, the original shall be kept with the HWRB QA Coordinator and a copy shall be provided to the NHDES QA Manager. The current official version of the Master HWRB QAPP will be available on the NHDES Website at [http://des.nh.gov/organization/divisions/waste/hwrp/documents/hwrp\\_master\\_qapp.pdf](http://des.nh.gov/organization/divisions/waste/hwrp/documents/hwrp_master_qapp.pdf). Paper copies generated for use on a particular job are not considered official copies. Other links may be provided as seems appropriate.

Please note that this is a dynamic document and subject to revision. At a minimum, this QAPP will be reviewed annually, and updated if necessary, as part of the NHDES Quality Assurance Program, (<http://des.nh.gov/organization/commissioner/p2au/pis/qap/index.htm>). This document shall be valid for a period of up to five years from the official date of approval.

The QA Coordinator will notify all HWRB personnel and the contact person for each contractor of any revisions to this QAPP by email.

All HWRB Project Managers will be required to review this QAPP and sign the “QAPP Project Personnel Log Sheet” which documents that they have reviewed this QAPP and will follow the procedures as described.

The contact person for each contractor will be required to review this QAPP and sign the “QAPP Project Personnel Log Sheet” which documents that they have reviewed this QAPP and that their company will follow the procedures as described.

The “QAPP Project Personnel Log Sheet” is found in Appendix I of the original QAPP kept with the HWRB QA Coordinator.

### **1.6.1 Documentation of Field Activities**

Field personnel shall use field logbooks and/or pre-printed field work sheets to accurately document all field activities: on-site conditions; field measurements; sample collection information; field instrument and calibration information; and other pertinent site-related

information during monitoring activities. All information shall be recorded in permanent ink. Refer to Appendix E for Well Sampling Worksheet currently being used by the HWRB.

The field notes shall include a description of field conditions that includes, as a minimum:

- Site location
- Date, start, and finish times of the work and weather conditions;
- Name and initials of person making entry;
- Names of other personnel present, if any;
- Names of visitors, if any;
- Purpose and summary of proposed work effort;
- Details of any deviation from the field operations plan or standard operating procedures, including who authorized the deviation;
- Field observations;
- Sampling equipment used (including make model and serial number) and equipment calibration documentation;
- Field screening methods, if used, and a description of screening locations;
- Field screening results, and identify samples with both field and fixed lab analyses;
- Fixed laboratory sample identification number, sample type (composite, grab), time of sampling, sample analysis, and sample locations shown on a near-scale map relative to a fixed landmark;
- Sample handling, packaging, labeling, and shipping information (including destination);
- Location, description and unique identifier for all photographs taken in association with the field activity; and
- Any other pertinent information

Information recorded in other site documents, *e.g.*, sampling logs, will not be repeated in logbooks except in summary form.

Any corrections to the logbook or other written documentation shall be initialed and dated. All corrections shall be shown as a single line through the original. The unused bottom portion of each page shall be lined-out, initialed, and dated.

### **1.6.2 Technical Reports of Field Activities**

Technical reports documenting the findings of site sampling work shall be submitted to NHDES. The type, number and contents shall be determined by the NHDES Project manager and specified in site-specific SAP.

Each report may include, but is not limited to, the following information:

- Summary of sampling activities;
- A copy of the complete laboratory report, including the chain of custody forms and applicable data validation reports;
- A list of equipment used, including make and models;
- All calibration information including the calibration log which contains the standards used, lots numbers, expiration dates, calibration checks, etc.
- A copy of all field sampling sheets and logs;

- Site map;
- Data summary tables of the compounds of concern detected at each sampling location during the current sampling event, highlighting any compounds that exceed cleanup goals;
- Historical data summary tables showing the history of the compounds of concern detected at each sampling location, highlighting any compounds that exceed cleanup goals with graphs of the same;
- Water level and elevation table showing historical data;
- Groundwater Potentiometric Surface Map;
- Isoconcentration Contour Maps for Site COPCs;
- A Quality Assurance/Quality Control Section. See below for specifics;
- Recommendations for any remedial action; and
- Recommendations for future modifications to the current monitoring program or to the SAP, if appropriate.

### **Quality Assurance/Quality Control Section of Report**

This section should include general statements summarizing whether or not the quality control criteria in the SAP & QAPP were met in the field and in the lab. List any QA/QC problems and how they were resolved. Please note anything unusual that will affect the quality or usability of the data.

If the quality control criteria was not met:

- How does that affect the usability of the data?
- Can we use the data? If not, why not?
- Was any corrective action needed and what, if any, measures were taken?
- What changes are recommended for the future?

Examples of possible issues:

- Were contaminants found in the equipment blanks?
- Were any samples broken in transport to the lab?
- Did the lab report any difficulties, issues?
- Were the sample tags mixed up in the field if the results look abnormal?

### **1.6.3 Document Handling and Retention Times**

In order to comply with Waste Management Division Submittal Guidelines, located at [http://des.nh.gov/organization/divisions/waste/orcb/documents/electronic\\_submittal\\_guidelines.pdf](http://des.nh.gov/organization/divisions/waste/orcb/documents/electronic_submittal_guidelines.pdf), the Department requests that all reports be submitted electronically through One Stop at this web address. <https://www2.des.state.nh.us/OnestopDataProviders/DESLogin.aspx>. You may also call 603-271-7379 for assistance.

All site related reports and project plans including QAPPs, SAPs, laboratory reports, site sampling reports, and annual reports shall be submitted and maintained in electronic project files and reviewed by the appropriate Project Manager to evaluate the usability of the data and assure

compliance with the elements of this QAPP. Copies of the Lab reports and pertinent information shall be provided to the EPA Project Manager, upon request.

Information collected for enforcement or litigation purposes shall be held in a separate confidential electronic file unless specifically released to the open file by the New Hampshire Department of Justice.

Electronic project files shall be located on the NHDES computer network server and available to view on the OneStop website, <http://des.nh.gov/onestop/index.htm>. These files are backed up on a regular basis by the Office of Information Technology. Additional information is provided in Chapter 7, section 7.8, Network Management, Data Back Up, Data Recovery Procedures, and Virus Protection of the current NHDES QMP located at <http://des.nh.gov/organization/commissioner/pip/publications/co/documents/r-co-06-3.pdf>.

Retention and archiving of records is done in accordance with specific statutory or regulatory requirements (additional guidance is provided in Chapter 6 of the current NHDES QMP). See Appendix J for the current HWRB Records Retention Policy.

All records of the Federal Sites Superfund program shall be maintained according to the Federal Sites Superfund Record Retention Schedule approved by NHDES, the State Records Manager and the State Archivist in 2004.

All records of the State Sites Remediation Program shall be maintained according to the Draft State Sites Remediation Program Record Retention Schedule.

Contractor records shall be maintained for seven (7) years following completion of the project. At the end of the retention period, the Contractor shall offer the records to the State. If the State declines to accept the records, the records become the property of the Contractor.

#### **1.6.4 Sample Numbering System for the NHDES Lab**

If sample results are to be entered into the NHDES EMD (Environmental Monitoring Database) samples identification must be compatible with the EMD format using a designated NHDES station identification (ID). It is the HWRB Project Manager's responsibility to provide the contractors with the correct station IDs. New station IDs must conform to the EMD requirements and must be fifteen (15) characters or less. For the federal (Superfund) sites, the site prefix and underscore is included in the fifteen characters (i.e. "KMC\_" as in "KMC\_MW-3010"). The station IDs can only be added to the database by certain qualified personnel at this time. Program Managers can direct you to the correct personnel for this task.

- Equipment Blanks must be labeled "Equip Blank". The equipment from which the equipment blank was collected must be indicated in the comments section of the chain-of-custody form. The description of the equipment blank must be short so the Laboratory can include the description on the sample's analytical results sheet.

- Trip Blanks must be labeled “Trip Blank” without any other designation. If more than one Trip Blank is delivered with any group of samples, it shall be clearly noted on the chain of custody form(s) which samples are associated with each Trip Blank, (Example: Trip Blank, sample a, sample b, sample c, Trip Blank, sample x, sample y, sample z, Trip Blank, sample .....)
- Sample duplicates are identified by adding “DUP” to the end of the station ID. The duplicate sample must be labeled “DUP” not “Dup” and there must be one space between the sample ID and DUP (example “KMC\_MW-3010 DUP”). Blind duplicates are not allowed. The “space DUP” will not affect the fifteen (15) character name.

## **1.7 Data Assessment**

All data generated shall be reviewed by the contractor and the Project Manager to ensure that the data has met the objectives and requirements of this QAPP and that the results are technically valid, reliable and usable. Sampling and analytical results shall be reviewed to determine if:

- Corrective action is necessary;
- The sampling plan should be revised; or
- The site should be re-sampled.

In order to ensure that the data has met the objectives and requirements of this QAPP and that the results are technically valid, reliable and usable, data shall be reviewed and compared with relevant documentation such as:

- Available Historical data;
- Laboratory MDL and RDL;
- Standards established in site specific Records of Decisions (RODs), if applicable;
- Standards and methods established in the current New Hampshire Administrative Rules, including but not limited to, the Ambient Groundwater Quality Standards (AGQS), Drinking Water Quality Standards, Surface Water Quality Regulations, and Ambient Air Quality Standards;
- Current Department Policies, including but not limited to, the Risk Characterization and Management Policy;
- Current Waste Management Division requirements such as the “Changes in VOC Analytical Requirements” concerning the updated “Full list of Analytes for Volatile Organics”; and
- Other pertinent documents as needed.

If data of questionable quality is reported or other quality control issues are uncovered, the Project Manager shall report the issues to the QA Coordinator and/or QA Manager. The Project Manager, with input from quality assurance personnel, shall determine the usefulness of data in question and at minimum shall summarize that data concerns in the report for which the data was generated.



The need for corrective action, including the collection of new or additional samples, shall be determined based on the data quality objectives for the project and with input from quality assurance and other appropriate personnel. If additional corrective action is necessary, it will be carried out as described in Section 1.8 - Corrective Action.

The Lab performs validation of test data in accordance with their procedures. The level of data validation, including Tier I, Tier II and Tier III validation, shall be identified in the site specific SAP by the Project Manager in consultation with the QA Coordinator.

It is the contractor's responsibility to ensure that all sampling procedures and techniques are conducted in accordance with the QAPP and any site specific SAPs. This can best be assured by the use of field audits. When long term monitoring is required, field audits on each sampling procedure/activity shall be conducted by the contractor during the first sampling event and periodically thereafter to ensure that the sampling procedures and techniques are conducted in accordance with the QAPP. Field audits shall also be conducted if the field team is changed from one sampling round to the next or the scope of work for the project changes significantly from one sampling round to the next.

EPA and/or NHDES quality assurance personnel shall periodically conduct separate field audits; review field methods, analytical procedures and/or document tracking and record keeping practices, to assure compliance with the elements of this QAPP. When long term monitoring is required, field audits on each sampling procedure/activity shall be conducted by NHDES quality assurance personnel once the contractor has completed their initial field audit and made any appropriate corrections; and periodically thereafter to ensure that the sampling procedures and techniques are conducted in accordance with the QAPP. Field audits shall also be conducted if the field team is changed from one sampling round to the next or the scope of work for the project changes significantly from one sampling round to the next. Both the NHDES and contractor project managers along with the contractor's QA officer should be present during the EPA and /or NHDES audits (unless the audits are unannounced).

## **1.8 Corrective Action**

Corrective actions must be taken as soon as possible when data or field procedures are found to be of questionable quality. Any suspected problems shall be brought to the attention of the NHDES Project Manager and the QA Coordinator.

The need for corrective action may be identified in many ways. The corrective action steps are:

- Identification and definition of the problem;
- Investigation of the problem;
- Determination of the cause of the problem and appropriate corrective action (this may include the need for additional training);
- Implementation of the corrective action;
- Verification that the problem has been corrected;
- Modification of procedures, as necessary, to prevent recurrence; and
- Document the events.

## **2.0 MONITORING AND SAMPLING PROCEDURES**

This section describes the overall design of the field program and includes the specific information necessary to conduct the monitoring and sampling components of the program. The monitoring and sampling procedures, sample handling and custody requirements, analytical method requirements, and the quality control (QC) requirements are presented in this section and the associated appendices

### **2.1 Generic Sampling Strategies and Procedures**

Sampling situations may vary with the media encountered during site sampling projects and projects may be of a simple or complex nature. Liquid, solid phase media and/or vapor phase media may occur in containers, drums, tanks, soils, sediments, pore water, wastewaters, runoff waters, surface waters, waste piles, lagoons, ponds, sludges, well points, piezometers and overburden and bedrock monitoring wells. The composition of media being sampled will vary considerably in the volume, size, physical state, and hazardous/chemical properties. In addition the site situation may have specific factors that affect sampling tasks, such as: accessibility; climate; waste generation/handling; transitory events; and other site hazards.

Sampling personnel shall be responsible for collecting representative samples of impacted, or potentially impacted, media at sampling site locations, and to ensure they are obtained in accordance with sampling procedures/methods found herein, in the SAP, and other reference documents.

The Project Manager is responsible for determining the number of samples and the method of sample collection in accordance with standard operating procedures, site conditions, and project requirements. Economic/financial resources/constraints, time allocation, availability of personnel, equipment, site conditions and sample variability are factors the Project Manager shall consider and review in the development of a site specific SAP.

Examples of acceptable sampling methods are: simple random sampling; stratified random sampling; systematic random sampling; composite sampling; grab sampling; biased and unbiased sampling; low flow purging and sampling; modified low flow purging and sampling; diffusion bag sampling; discrete interval sampling (such as with a Hydrasleeve) groundwater/surface water interface sampling (pore water sampling), and the snap-sample technique. These methods are explained herein and in the referenced documents. See Appendix C for the current SOPs in this QAPP.

Depending on circumstances and needs, it may not be possible or appropriate to follow the SOPs exactly in all situations due to site conditions, equipment limitations, and limitations of the standard procedures. When necessary to perform an activity that does not have a specific SOP, or when the SOP cannot be followed, existing SOPs may be used as general guidance or SOPs similar to those found in this QAPP may be adopted if they meet the data quality objectives of the project. All modifications or adoptions shall be approved by the Project Manager and documented in the SAP.

Refer to the current New Hampshire Code of Administrative Rules, Env-Or 600 Contaminated Site Management, (Env-Or 610.02 (e)) located at <http://des.nh.gov/organization/commissioner/legal/rules/documents/env-or600.pdf> for a list of documents containing environmental sampling methods not found in Appendix C, Standard Operating Procedures of this QAPP.

The following documents are currently listed there:

1. "Practical Guide for Ground-Water Sampling," document identification number EPA/600/2-85/104, US EPA, dated September 1985;
2. "RCRA Ground-Water Monitoring: Draft Technical Guidance," document identification number PB87107751, US EPA, dated November 1992;
3. "Standards on Environmental Sampling", 3rd Edition, document identification number ASTM ENVSAM-06, dated 2006 (ASTM ENVSAM-06);
4. "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, Second Edition" document identification number EPA/625/R-96/010b, US EPA, dated January 1999;
5. "SW 846 Test Methods for Evaluation Solid Waste, Physical/Chemical Methods", US EPA, dated December 1996; and
6. "Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds" document identification number ASTM D 4547-06, dated 2006.

## **2.2 Sampling Equipment**

The choice of sampling equipment and sample containers will depend upon the media being sampled and site considerations. The sampling equipment shall be selected to ensure that a representative sample is collected. Appendix B Sampling Equipment / Field Equipment has a list of equipment most commonly used, however, additional equipment may also be used as needed. Sampling equipment shall be clean (decontaminated) before use to minimize the potential for cross-contamination and whenever possible, new/unused sampling equipment shall be utilized. The HWRB requires that a fiberglass measuring tape or other accurate measuring device be used when measuring and installing tubing.

The SAP shall require pertinent information, including the make, model and serial number, on all equipment necessary for field sampling and health and safety purposes to be documented. Copies of the operating instruction manuals and calibration procedures shall be kept with the equipment and in the contractor/HWRB files. The SAP shall require that all manufacturers' equipment manuals and any manufacturer-provided repair kits will be on-site at all times during the sampling event.

## **2.3 Decontamination**

See Appendix C for the Decontamination SOP. Lab personnel can assist in determining an appropriate solvent. Disposable sampling equipment shall be discarded after completing the

sampling task and not reused. Decontamination of equipment generates Investigative Derived Waste (contaminated rinse liquids, sludges, etc.) that may need to be containerized onsite until proper disposal arrangements are made. The Project Manager will use professional judgment and guidance documents such as Guide to Management of Investigation-Derived Wastes, EPA 93-45303fs-s, January 1992, located at <http://www.epa.gov/superfund/policy/remedy/pdfs/93-45303fs-s.pdf>, on a site by site basis to determine if the levels of contamination are sufficiently low so that disposal at a hazardous waste facility is not necessary, and shall document it in the SAP.

## 2.4 Instrument Calibration and Maintenance

In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, calibrated, tested and inspected according to the manufacturer's instructions. All of these instruments shall be calibrated at the beginning of each sampling day at the Site. The calibration shall then be checked to ensure the instrument was calibrated properly. The calibration shall be checked again at the end of the day of use to ensure that the instruments have remained in calibration throughout the day. In addition, should any erratic or illogical readings occur between calibrations, the instrument shall be recalibrated in order to ensure that representative measurements are obtained. All calibration, check values and maintenance activities shall be documented on a calibration log in a manner that is traceable to the equipment. Refer to the Calibration of Field Instruments SOP in Appendix C for specific calibration procedures and a generic Calibration Log.

Each SAP shall contain:

1. A table listing equipment, calibration frequency, calibration standards, calibration acceptance criteria and corrective action. See the example on the next page.
2. A table listing equipment, maintenance and frequency and another table listing equipment, calibration frequency, calibration standards, calibration acceptance criteria and corrective action. See example below.

**Example: Field Equipment - Preventive Maintenance Table**

INSTRUMENT	ACTIVITY	FREQUENCY
Multi-Parameter Water Quality Meters: YSI models 600XL or 6820; QED MP-20	Battery check Calibration – beginning of day Calibration check – beginning of the day Calibration check – end of day	Daily
Hach 2100P Turbidity Meter	Battery check Calibration – beginning of day Calibration check – beginning of the day Calibration check – end of day	Daily
Electronic Water Level Indicator	Battery Check	Daily
QED Bladder Pump Controller Model MP-10 or 400	Battery Check	Daily

**Example: Field Equipment - Calibration and Corrective Action Table**

Parameter	Calibration Standards	Acceptance Criteria For The Daily Calibration Checks <sup>1</sup>	Calibration Frequency	Corrective Action
Multi-parameter Meters: YSI models 600XL or 6820, QED MP-20; Turbidity Meter: 2100P Hach Turbidity Meter				
Dissolved Oxygen (DO) & Temperature	Calibrated to 100% Water Saturated Air .... Use 0 mg/L DO solution to check	< 0.5 mg/l for the 0 mg/l solution	Daily Calibration at the beginning of the day	<b>Daily Calibration</b>  Recalibrate with the appropriate standards.
Oxidation Reduction Potential (ORP)	Zobell Solution .... Is used to calibrate and check	+/- 5%	Calibration Check at the beginning of the day after calibration	If it is still outside the acceptance criteria then replace with a different unit.
Specific Conductance	447 µS/cm to Calibrate .... 1413 µS/cm as a check <sup>2</sup>	+/- 5%	Calibration Check at the end of the day	<b>Calibration Checks:</b>  If outside the criteria at the beginning of the day, recalibrate the instrument with new standards. If recalibration is unsuccessful, replace the unit.
pH	7, 4, 10 units .... Use pH 7 to check	+/- 5%		
2100P Hach Turbidity Meter	< 0.1, 20, 100, 800 NTUs <sup>3</sup> .... Use the 20 NTU standard to check	+/- 5%		If outside the criteria at the end of the day, the data will be qualified by the contractor.
Notes: <sup>1</sup> The Checks are a check of the instrument against the calibration standards and is performed in the "measurement or run" mode. This is not recalibration, but rather a check.				
<sup>2</sup> The lower 447 µS/cm standard is used to calibrate, the higher 718µS/cm or 1413 µS/cm standard is used to check the standard and the linearity of the instrument.				
<sup>3</sup> Use StablCal® Formazin Primary Turbidity Standards.				

## 2.5 Field Screening Instruments

At some sites sampling personnel may be required to use field instruments such as an organic vapor photoionization detector (PID) meter or a combustible gas and oxygen detector (CGI) to evaluate

the safety of the site or sampling areas prior to initiating sampling. Instruments shall be calibrated prior to use in accordance with the manufacture's instructions and copies of the operating instruction manuals and calibration procedures shall be kept onsite with the equipment as well as in the contractor/HWRB files. All instrument readings shall be recorded in the sampler's calibration log, and field notebook/worksheet.

## **2.6 Laboratory Services**

Analytical services shall be provided by laboratories which are currently accredited under the National Environmental Laboratory Accreditation Conference (NELAC) standards and have their own quality assurance manual and standard operating procedures (SOPs) that meet the NELAC standards. The laboratories providing the services should, wherever possible, be accredited for the specific matrix / method / analyte for which testing is required. In some cases, this may not be practical; then a laboratory that is accredited for the equivalent technology (i.e. GC-MS, ICP-MS, etc.) shall be used, subject to Project Manager approval. Additional information on accredited laboratories and the laboratory accreditation program may be found on the NHDES Website at <http://des.nh.gov/organization/divisions/water/dwgb/nhelap/index.htm>.

Each laboratory shall have a separate quality assurance manual which is not covered in this QAPP. The NHDES Laboratory has a quality assurance manual entitled, "The New Hampshire Department of Environmental Services Laboratory Services Unit Quality Systems Manual".

For projects which use a field laboratory, the Project Manager and QA Coordinator will work with the specific laboratory to assure that quality control measures meet the DQOs of the particular project or event. Additionally, confirmatory samples will be submitted to an accredited lab for analysis.

Each SAP shall contain a summary table of analytes, analytical test methods, regulatory action limits and the laboratory reporting limits/ detection limits and for all compounds tested on site. See Appendix G Site Analytes Associated Regulatory Standards & Lab Criteria for an example table.

The NHDES Waste Management Division has a document on our website concerning the updated of the "Full List of Analytes for Volatile Organics" (Full List). The NHDES Laboratory's 8260B list is the same as the Full List; however the limits for the compounds with the asterisk are not as low as on the list. If you need to reach those limits, different methods are required. In addition other laboratory's 8260B method may not include the Full List. For specific VOC analytical requirements, please refer to the document located at: [http://des.nh.gov/organization/divisions/waste/hwrb/documents/voc\\_changes.pdf](http://des.nh.gov/organization/divisions/waste/hwrb/documents/voc_changes.pdf)

## **2.7 Sample Volume, Containers and Labeling**

Containers used for collecting samples shall be compatible with the media being sampled and analysis to be performed. Containers shall be obtained from the analytical lab and shall be clean, free of contamination, and, if required, contain the proper preservative. Care shall be taken during sampling to ensure that material is not spilled onto the outer surface of containers, and that lids are

placed on tightly after sampling. The volume sampled shall be in accordance with the analytical lab's requirements. Containers shall be labeled with the date and time sampled, sample location, collectors initials, sample number, project name or number, preservative and any other pertinent information. Information shall be documented in field notebooks/worksheets and chain of custody forms, where applicable.

## **2.8 Sampling Preservation and Holding Times**

Holding times and sample preservation shall be in accordance with the analytical method, and/or the analytical lab's requirements whichever are more stringent. When sampling containers contain preservatives, care shall be taken during sampling process to ensure the preservative is not spilled or diluted by overfilling. Preservation, storage conditions and sampling time shall be recorded in field notebooks/worksheets and chain of custody forms, where applicable.

Each SAP shall contain a summary table of the media, analysis, test methods, containers, sample volumes, preservation and hold times. See Appendix H for an example summary table of Media and Laboratory Requirements.

## **2.9 Chain of Custody and Sample Delivery Procedures**

See Appendix C for the Chain of Custody Sample Handling & Shipping SOP. Samples and empty sample containers shall remain in the sample collector's view at all times, unless locked in a vehicle or other secure place. It is the sampler's responsibility to ensure that the samples are not tampered with prior to their delivery to the analytical lab. The Chain of Custody (COC) form shall be completed to provide documentation tracing sample possession and handling from the time of collection through delivery to the analytical lab, and shall accompany the samples at all times. The COC is a legal document that may be used for litigation purposes.

Analytical laboratories often require the use of a specific COC form. The current NHDES Laboratory's COC form is attached as Appendix D. If other COC forms are required, this shall be specified in the site-specific SAP. Labeling the COC shall be consistent with the sample container labeling described in Section 2.7 (above).

The completed original COC shall be attached to the analytical report which is submitted to the HWRB, and becomes part of the permanent project record. The original COC forms and associated analytical results for State Lead Superfund Sites shall be sent to the QA Coordinator for review.

Samples shall be properly packaged in a cooler for shipment to maintain sample integrity and delivered to the analytical laboratory along with a separate signed COC form enclosed in each sample cooler. Samples must be delivered in a manner consistent with the requirements of the analytical laboratory with respect for preservation, temperature, holding times for the particular analytes to be tested. Custody seals shall be used when the cooler is sent to the laboratory by independent courier, unless otherwise specified in the Site SAP.

## 2.10 Laboratory Sample Management

Lab personnel shall log the samples into their computer in accordance with their standard operating procedure. The samples shall be inspected by the Laboratory Sample Controller, or other qualified laboratory personnel. A Sample Receipt Checklist shall be used to document the receipt of the samples and shall include checks for breakage, correct container and preservative, temperature of the cooler, holding times, and for other factors that may affect quality. The samples shall be compared to their description on the COC form, and discrepancies in the number or the designations of the samples shall be noted on the form and shall be brought to the attention of the person who relinquished the samples to the lab. If necessary, the contact person on the chain of custody may be contacted for further instruction. Since samples may be held in the lab untouched until discrepancies are resolved, there could be an impact on sample holding times.

The COC form shall be signed and the date and time shall be recorded to formally accept the samples into laboratory custody. The analytical laboratory shall assign laboratory numbers to the samples, and these numbers shall be recorded on the chain of custody forms.

## 2.11 Sample Quality Control

The following are routine field quality control samples.

- Trip Blanks

Trip blanks for volatile organic compound (VOC) samples shall be prepared by the laboratory prior to the sampling event using analyte-free water. The trip blanks shall accompany the sample containers to the field, during collection and transportation and shall be submitted with the other samples for analysis. There shall be one set of trip blanks per VOC sample cooler. The analysis of this blank will provide a baseline measurement of VOC contamination that the samples may have been exposed to in the field and during transport.

**Note: Separate Trip Blanks may be required for VOCs and 1,4-Dioxane. Consult with the specific laboratory for their requirements.**

- Equipment Blanks

Equipment blanks consists of a sample of distilled/deionized (analyte-free) water which has been poured around and through sample collection equipment to determine if contamination has occurred due to improper cleaning and/or contamination of equipment. They shall be handled like any other sample (*e.g.* preserved), and submitted with the other samples for analysis. The frequency shall be determined based on the type of sampling that occurs and additional equipment blanks shall be required for changes in sample matrix or equipment type as specified in the site specific SAP. Equipment blanks shall not be required where disposable or dedicated sampling equipment is used.



- Duplicate samples

Duplicate samples shall be collected for each batch of samples (a batch may not exceed 20 samples) collected per matrix, per analysis. The duplicates shall be collected at the same time, in the same manner as their corresponding routine samples and shall be identified in the field notes and logged on the chain of custody forms.

- Background Samples

Upgradient samples may be taken to determine the local naturally occurring conditions. The background samples shall be used as control samples and taken outside the area of contamination. These results shall be compared against actual contaminated sample results. The use of background samples shall be specified in the site specific SAP.

- Split Samples

Split samples may be collected to compare the analytical results from one laboratory to another using the same techniques or methods, or to compare the analytical results of different laboratory techniques or methods to determine whether they are generally equivalent. Split samples are identical samples that are collected from the same location at a given time, and divided into two or more portions. Split samples may be collected for one analyte, for a group of analytes, or for all analytes that are being quantified. The number of split samples to be collected shall be determined by the Project Manager.

Split samples cannot always be placed in identical sample containers due to the differing quantity or container requirements of various analytical laboratories. It is difficult to accurately split a heterogeneous sample, such as a soil sample, and the sampling team should distribute the sample as uniformly as possible and fill split containers for one analyte at a time. If the sample collection device contains insufficient sample, an equal portion of the sample should be placed in each of the split sample containers and additional sample should be collected and split to fill the containers.

All SAPs shall include the following quality assurance tables:

- A table of the summary of quality assurance samples for that sampling event. See Appendix I for an example of a Table of Summary of Quality Assurance Samples; and
- A summary Table of Field Quality Control Requirements such as the example on the next page.

**Example: Field Quality Control Requirements Table**

QC Sample	Frequency	Acceptance Criteria	Corrective Action
<b>Duplicate</b>	<ul style="list-style-type: none"> <li>1 duplicate per batch 20 samples; per matrix; per parameter.</li> <li>A minimum of one duplicate for each sampling method (i.e. low flow sampling, purge 3 volumes, Barcad, sediment, surface water, pore water, etc.) shall be collected per matrix, per analysis</li> <li>See <b>Table 5</b> for analysis.</li> </ul>	Duplicate concentrations are within +/- 30% for aqueous samples and 50% for solid samples	Flag in project report
<b>MS/MSD</b>	The NHDES Lab requires that four – 1-liter amber bottles be collected for one sample for SVOCs instead of the usual 2 bottles, for lab quality control. This will be separate and in addition to the duplicate sample collected above. See <b>Table 5</b> .	N/A	N/A
<b>VOC Trip Blank</b> (separate trip blanks required for VOCs & 1,4- Dioxane)	1 per cooler containing VOC samples	No contaminants are detected	Flag in project reports
<b>Equipment Blank</b>	If dedicated equipment used, an initial equipment blank is required. No additional equipment blanks are required. If non-dedicated equipment is used, one equipment blank per sampling event, per equipment type is required; See <b>Table 5</b> for analysis.	No contaminants are detected	Flag in project reports

Notes:

- Duplicate samples are not intended to be blind duplicate samples. They will be designated with a "DUP" after the well designation (i.e. GIL\_T-8-3 DUP).
- Trip blanks will be prepared by NHDES' laboratory and maintained at all times with the sample containers. The trip blank(s) will be designated "TRIP BLANK".
- Equipment blank samples will be designated as "EQUIP BLANK". Note that a comment is required on the chain of custody indicating what the equipment blank is for (i.e. water level meter)
- Table 5** refers to a Table of the Summary of Quality Assurance Samples for that sampling event (see Appendix I for an example of that table.)

### 3.0 REFERENCES

Refer to the most recent editions of the following:

U.S.EPA. 1999. The Region 1, EPA-NE Compendium of QAPP Requirements and Guidance, Final October 1999 with Attachments

\_\_\_\_. 2006. EPA Requirements for Quality Assurance Project Plans. EPA QA/R-5

\_\_\_\_. 1987. A Compendium of Superfund Field Operation Methods. EPA 540/P-87/001. August.

\_\_\_\_. Practical Guide for Groundwater Sampling. EPA 600/2-85/104

\_\_\_\_. 1986. Test Methods for Evaluations Solid Waste, Third Edition. EPA SW 846

\_\_\_\_. 1982. Handbook for Sampling and Sample Preservation of Water and Waste Water. EPA 600/4-82/029

\_\_\_\_. 1996. Region 1, Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells. EPA SOP #GW-0001. July.

\_\_\_\_. 1998. Region 1, Draft Calibration of Field Instruments. June

\_\_\_\_. 1996 Environmental Investigations Standard Operating Procedures and Quality Assurance Manual Athens, GA. May with 1997 Revisions  
<http://www.epa.gov/region04/sesd/eisopqam/>

American Society for Testing Materials (ASTM) Standards on Environmental Sampling. Second edition 1997

\_\_\_\_. Standard Guide for Sampling Groundwater Monitoring Wells. D 4448-85A.

\_\_\_\_. Standard Practice for Decontamination of Field Equipment Used at Non-Radioactive Waste Sites. D 5088-90

\_\_\_\_. Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds. D 4547-98.

State of New Hampshire. New Hampshire Department of Environmental Services Laboratory Services Unit Quality Systems Manual

\_\_\_\_. New Hampshire Department of Environmental Services Quality Management Plan.

## **APPENDICES**

**APPENDIX A**  
**PROGRAM ORGANIZATION AND RESPONSIBILITIES**  
**ORGANIZATIONAL CHART**

## **PROGRAM ORGANIZATION AND RESPONSIBILITIES**

In accordance with the Master HWRB QAPP, and the NHDES Quality Management Plan (QMP), the following individuals will be responsible for major activities performed in the project plans. Class specifications and supplemental job descriptions covering education and experience requirements for specific positions under state law are available through the Division of Personnel in the Department of Environmental Services.

The program manager shall be responsible for ensuring that staff have and maintain appropriate training. NHDES provides in-house training and provides for staff participation in other training, such as local and regional workshops. All HWRB personnel and contractors shall be certified by EPA training course Personnel Protection and Safety (165.2) or Hazardous Materials Incident Response Operations (165.5). Annual refresher courses are required. The QA Manager and the QA Coordinator shall receive specific QA/QC training as needed to ensure that both are qualified to perform the tasks relating to the QAPP. This training may include conferences and training classes provided by private industry, the NHDES or USEPA. Additional training shall be provided for all personnel as it is deemed necessary.

### **Quality Assurance (QA) Manager**

- Oversees the implementation of NHDES' quality systems;
- Maintains independence and impartiality of the data quality review;
- Has no data gathering or reviewing responsibilities that would lead to a possible conflict with the Quality Assurance Manager role;
- Serves as the liaison between the NHDES and the QA staff at USEPA Region I on Quality Assurance/Quality Control (QA/QC) matters;
- Provide interpretations of NHDES QA/QC policies and coordinate the development of policies and procedures that are consistent with the USEPA requirements and NHDES goals;
- Performs the reviews, assessments, and audits;
- Provides technical assistance to support the overall mission of NHDES;
- With program managers, develops guidance on QA/QC issues for use in NHDES;
- Resolves any disputes that may arise regarding quality assurance issues within or between various NHDES units;
- Assures that all program managers and staff understand and implement applicable quality assurance procedures; and
- Ensure proper procedures are being followed through system and performance audits.

### **Quality Assurance (QA) Coordinator**

- Responsible for the preparation of this QAPP, an annual review of the QAPP, any necessary revisions, and notifying all appropriate personnel of such;
- Responsible for adhering to the QAPP and assuring that the QAPP is adhered to by the Bureau;

- Works with the QA Manager to develop an acceptable quality assurance program for all environmental data generated or processed relating to the Hazardous Waste Remediation Bureau;
- Identifies and responds to QA needs and answers requests for guidance or assistance;
- Maintains lines of communication with the NHDES Lab to: ensure that all information for staff is received, resolves problems and implements corrective action;
- Receives and reviews the sampling reports from the NHDES Lab for quality control.
- Reviews site-specific SAPs to ensure that they adhere to the QAPP.
- Assist Project Managers in reviewing site sampling reports to ensure that they adhere to the QAPP and the site-specific SAPs.
- Assists QA Manager in ensuring that proper procedures are being followed.

### **Program Manager**

- Responsible for assuring that staff and State contractors follow the approved QAPP;
- Administers state and federal hazardous waste site programs and policies, insuring that they are properly implemented;
- Supervises and provides technical assistance to engineers, hydrogeologists, environmentalists, and waste management specialists involved in activities associated with the study and remediation of hazardous waste sites to ensure that all projects are completed in a timely and appropriate manner;
- Responsible for selecting the appropriate contractor for specific sites, with input from the Project Manager
- Reviews work performed by staff and others to ensure that all projects are conducted in accordance with the best professional practices;
- Assists the Division Director in establishing and implementing Division policies and procedures;
- Provides technical support to the Attorney General's Office as required in order to properly negotiate settlements with potentially responsible parties;
- Coordinates Department activities to secure permits and clearances from state and federal agencies to ensure that the remedial activities are in compliance with applicable environmental regulations;
- Coordinates with the EPA; and
- Responsible for ensuring that personnel have appropriate training and follow appropriate safety procedures.

### **Project Managers**

- Responsible for assuring that all site work is consistent with the QAPP;
- Responsible for the development and approval of Work-Scopes and site specific SAPs;
- Develops and administers multidisciplinary investigations and remedial actions at hazardous waste sites;
- Coordinates with the EPA Remedial Project Manager (RPM);
- Assures that approved procedures meet the project objectives;

- Responsible for implementation of recommendations made by QA Manager and/or QA Coordinator;
- Responsible for initiating corrective actions;
- Reviews and approves all site procedures;
- Reviews all site related documentation;
- Ensures that appropriate sampling and analytical procedures are followed;
- Monitors schedules for field, analytical, and data validation activities;
- Coordinates and oversees all sampling and analytical data assessment activities;
- Coordinates with the Lab for analytical support services and the Environmental Health Program for risk assessment evaluations;
- Ensures that the analytical method detection limit is reasonable for the analytical parameters selected and the media sampled;
- Monitors grant money and budget and reports financial activities to the USEPA; and
- Authorizes spending for equipment, samples and sampling supplies.

#### **Quality Assurance Officer for the NHDES Laboratory Services Unit (NHDES Lab)**

- Assures that sufficient quality assurance activities are conducted to demonstrate that all data generated by the Lab is scientifically valid, defensible, and of known precision and accuracy.
- For further detail on QA/QC activities of the NHDES Lab, see the Lab's QA/QC Program Plan.

#### **Permitting & Environmental Health Bureau**

- The Environmental Health Program (EHP) in the Permitting & Environmental Health Bureau (PEHB) provides services related to health risk assessments.

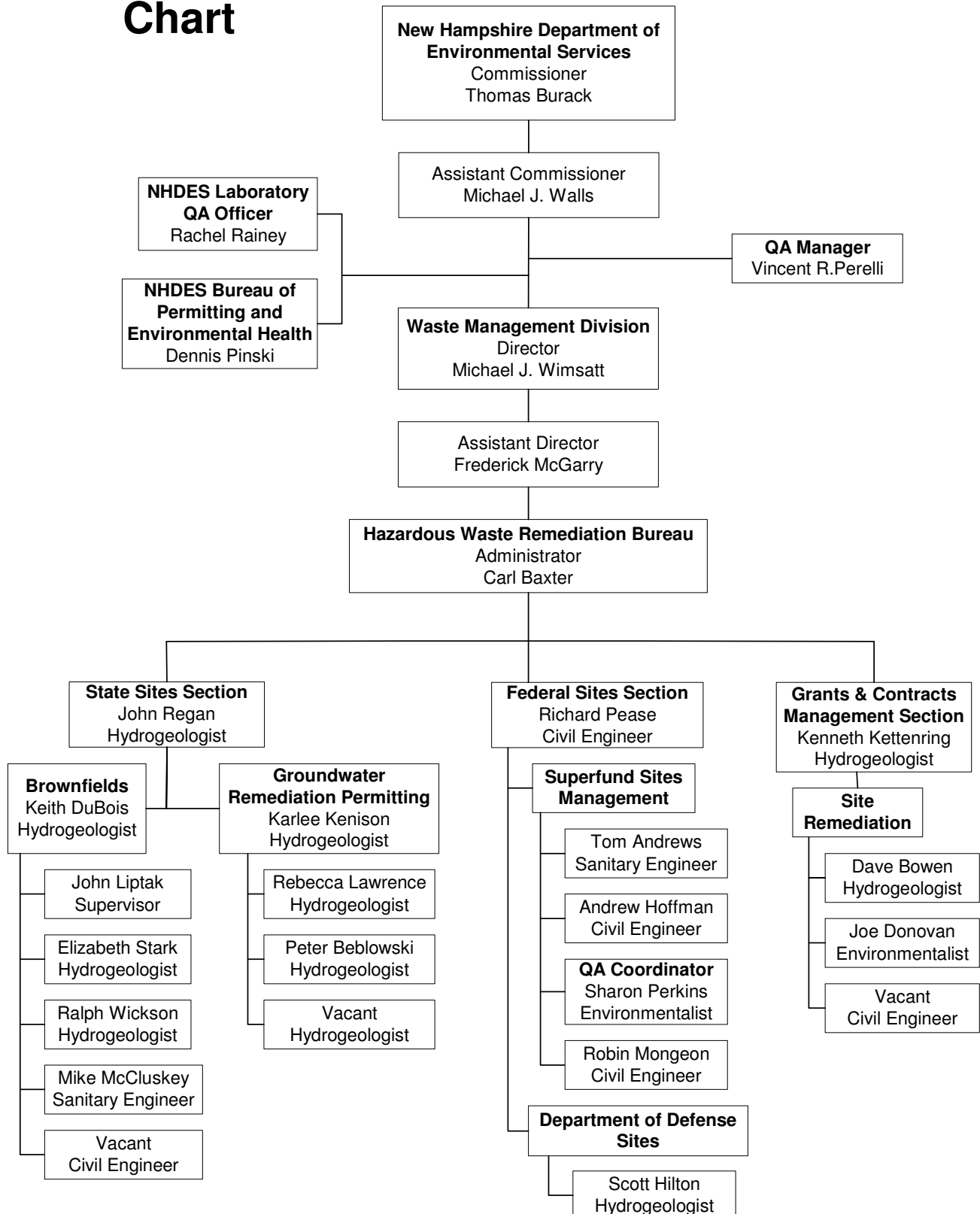
#### **Contractors**

- Responsible for following the approved QAPP and any approved site specific SAPs.
- Responsible for training their personnel in the proper sampling techniques and procedures as required, ensuring compliance with this QAPP and any site-specific SAPs. Training records shall be maintained by the employer of the staff and be available upon request.
- Overall contract management ensuring that established protocols and approved procedures are used.
- Coordinates with the Project Manager in the development of Work-Scopes;
- Coordinates with the Project Manager in the development of the site specific SAP;
- Performs QA aspects of the project including:
  1. Data review, including an in-house examination to ensure data has been recorded, transmitted, and processed correctly;
  2. Development of the Health and Safety Plan (HASP); and

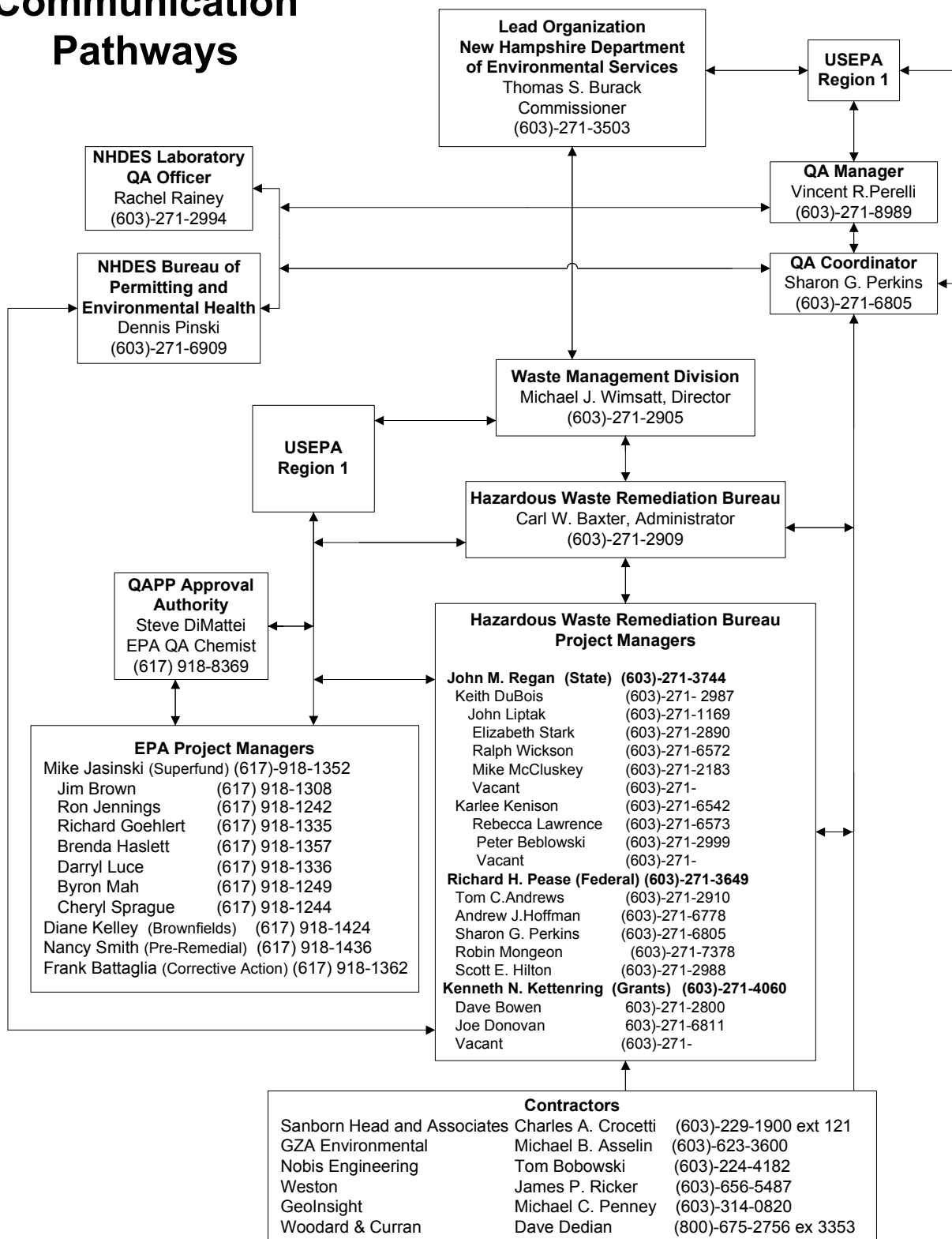


3. Any data validation reports required to ensure that the data has met the objectives and requirements of this QAPP and that the results are technically valid, reliable and usable.
- Prepare periodic project technical reports documenting the findings of site sampling work. The reports will include the analytical laboratory reports and the QC data as specified in the SAP.
- Coordinates sampling and field activities with the NHDES Project Manager and the lab
  1. Responsible for on-site coordination of field monitoring and sampling activities
  2. Assures that samples are collected in accordance with the QAPP, SAP and approved QA procedures
  3. Responsible for the equipment for field activities
  4. Responsible for sample chain-of-custody protocols and sample delivery to the lab
  5. Responsible for the collection of representative field samples
  6. Responsible for periodic auditing of field monitoring and sampling activities as outlined in the SAP

# Organizational Chart



## Communication Pathways



## **APPENDIX B**

### **SAMPLING EQUIPMENT / FIELD EQUIPMENT**

## **SAMPLING EQUIPMENT / FIELD EQUIPMENT**

This is a list of equipment most commonly used; additional equipment may also be used as needed.

Calibration of the field instruments will be conducted at least daily, prior to the use in the field. The field equipment will be maintained, calibrated and operated in a manner consistent with the manufacturer's guidelines and USEPA standard methods. Manufacturer instructions and other instructional documentation will be kept with the field staff. Additionally, all field equipment will be operated according to the HWRB's SOPs, when applicable. HWRB SOPs are found in Appendix C.

### Electronic Water Level Meter

It is used to measure water levels in wells to 1/100 of a foot, which can then be used to calculate purge volumes.

### Interface Probe

Similar to a water level meter but is able to differentiate between water and non-aqueous phase liquid (NAPL) contact. It is used to determine the thickness of NAPL layers aqueous in monitoring wells.

### Peristaltic Pump (Geotech Series II or similar model)

A low volume suction pump used for both purging and sampling which utilizes a deep cycle battery or generator for power. The maximum effective depth is approximately 29 feet.

### Submersible Pump (Grundfos Redi-Flo 2 or similar model)

A submersible centrifugal impeller pump used in conjunction with a generator, or direct source of electricity, for both purging and sampling. It is used in cases where the depth of the water prohibits the use of the peristaltic pump.

### Centrifugal Pump (Honda Pump or similar model)

A centrifugal pump is a type of suction pump that uses positive displacement of water. It has a maximum suction head lift of 26 feet and a maximum pumping rate of 53 gpm, and may be used for purging large volumes of water efficiently. Not used for sampling.

### Bladder Pump

A bladder pump is a pneumatic pump that incorporates both gravity and compression. It is recommended for purge volumes ranging from 0.5 gpm - 3.3 gpm. It can be used for purging and sampling.

### Wattera Hand Pump

This pump is not generally recommended. This pump can be used for purging wells and sampling if it fits the projects data quality objectives.

It fits into a well with an inner diameter of an inch, can operate at a maximum depth of 250 feet and has a maximum flow of 2 gpm.

#### Bailers

Bailers shall be made of stainless steel or Teflon. Bottom filling and bottom emptying type (bucket) bailers are used to purge wells and collect samples other than Volatile Organic Compounds (VOCs). Bottom dispensing bailers are required for sampling VOCs.

#### Barcad

A groundwater sampling instrument designed for permanent installation at a fixed depth. Typically a number of these instruments are installed at various depths in a cluster within a single borehole (monitoring well). The sampler contains a check valve through which water can be extracted from the formation and conducted to the surface via a small-diameter riser tube concentric within a larger gas-drive tube.

#### Barometer

A barometer is used in calibrating dissolved oxygen meters. A separate barometer may be used if the instrument doesn't already have a temperature-compensated barometer. All barometers (either separate or part of a multiparameter meter) must be checked, and adjusted if necessary, at least yearly against a known calibrated barometer such as one used by the National Weather Service.

#### Gas Cylinders

Portable tanks of compressed inert gas used in the operation of the Barcad sampling instrument.

#### Tubing

Dedicated polyethylene tubing (1/4" ID x 3/8" OD) will be used in all monitoring wells. Silicone tubing will be used in the pump heads of the peristaltic pumps.

#### Multi-Parameter Meter (YSI Models 600X1 or 6820, QED MP-20 or similar approved models)

This is a multiparameter meter with a flow through cell which measures temperature, specific conductivity, dissolved oxygen, pH, and ORP. These measurements are generally taken for the purpose of determining well stabilization and may also be used as part of the evaluation process of natural attenuation. The meter is calibrated daily before use following the manufacture's guidelines. Note: turbidity measurements must be obtained from a separate instrument as measurements through a flow through cell are not acceptable.

#### Turbidity Meter (Hach 2100P or similar model)

Measures the turbidity of water for the purpose of determining well stabilization or other purposes, as needed. It determines the turbidity by viewing light through the sample and determining how much light is obstructed. The meter is calibrated daily following the manufacture's guidelines.

pH Meter (Separate meter)

This meter may be used when a multiparameter meter is not required. Calibrate daily before sampling following the manufacture's guidelines.

Dissolved Oxygen Meter (Separate meter)

This meter may be used when a multiparameter meter is not required. Calibrate daily before sampling following the manufacture's guidelines.

Conductivity Meter (Separate meter)

This meter may be used when a multiparameter meter is not required. Calibrate daily before sampling following the manufacture's guidelines.

Thermometer

A separate thermometer may be used when a multiparameter meter is not required. All thermometers (either separate or in a multiparameter unit) must be checked at least yearly against a National Institute of Standards & Technology (NIST) Thermometer.

Auger

The system consists of an auger bit, a series of drill rods, a "T" handle and a thin-wall tube corer. The auger bit is stainless steel and is used to sample hard or packed solid media, soil or sediment.

Shovel

A regular lawn or garden shovel used to remove top cover of soil to desired depth for sampling. Not used to collect sample.

Scoops/Spoons

Made of stainless steel and used to collect soil samples.

Soil Sampling Device (EnCore™ or similar NHDES approved device)

A syringe type device used to collect soil samples in the field

Air Sampling Devices

Air sampling devices may be used in personnel protection and safety as a screening tool to decide whether a respirator, or a self-contained breathing apparatus should be worn, or whether the area should be evacuated. They are used primarily at locations where the air quality is unknown and may also be used for sampling such as for soil gas surveys.

Portable PID/FID Instruments (such as the HNU HW101)

Portable PID/FID instruments have traditionally been used as general survey instruments for headspace analysis of soil and groundwater samples and to determine safe breathing zones. These hand-held instruments employ either a photoionization detector (PID) or flame-ionization detector (FID) for detection of vapors/gases. They are calibrated using calibration check gas cylinders following manufacturer's manual.

#### MSA Combustible Gas and Oxygen Meter

The MSA Combustible Gas and Oxygen Meter model 261 is used to determine oxygen content and explosive limits for confined spaces such as well cap, truck bins, drums, closed and open store tanks. It is calibrated using calibration check gas cylinders following manufacture's manual.

#### Dust Meter

A dust meter is used to monitor dust during excavation in potentially hazardous work zones. It is calibrated using calibration according to the manufacture's guidelines.

#### Gas/Air Collection Containers

##### Stainless Steel Canisters (such as a Summa Canister)

Pre-evacuated passivated stainless steel canisters. Samples are typically collected under either pressurized or subatmospheric pressures.

##### Sampling Bags (such as Tedlar Bags)

They are air displacement containers. The bag is evacuated prior to use and a sample is collected by opening an inlet and using a pump for positive pressure.

#### Pore Water Samplers

A pore water sampler comes in two parts, a strengthening rod and the pore water sampler itself, both made of stainless steel. The pore water sampler is basically a hollow tube with small holes in its tip that allow groundwater to percolate through. The strengthening rod slides into the pore water sampler, and while in place, blocks all water from entering pore water sampler. Both pieces are placed in a PVC sheath for protection. Although the pore water sampler is fairly sturdy, exercise caution during use, as once either piece becomes bent, the equipment is useless.

#### Test Kits (Hach or similar)

Analysis for various parameters may be determined in the field through the use of Hach kits following the manufacture's instructions. Some of the parameters that may be tested using this method include alkalinity, ferrous iron, nitrate, sulfate, pH, and dissolved oxygen.



## **APPENDIX C**

### **STANDARD OPERATING PROCEDURES (SOPs)**

## SOP TABLE OF CONTENTS

This is a list of Standard Operating Procedures (SOPs) commonly used by the HWRB. Any additional SOPs needed for a specific site shall be approved by the project manager in consultation with the quality assurance coordinator. Any deviations from these SOPs shall be approved by the project manager in consultation with the quality assurance coordinator.

HWRB-1	Measuring the Static Water Level
HWRB-2	Calculation of Purge Volume Groundwater Volume in Well Casings for Calculation of Purge Volumes
HWRB-3	A Method for Determining Aquifer Stabilization, Revision 1
HWRB-4	Sampling With a Bucket Type Bailer, Revision 2
HWRB-5	Purging Wells with a Centrifugal Pump, Revision 1
HWRB-6	Sampling with a Grundfos Redi-Flo 2 Submersible Pump, Revision 2
HWRB-7	Purging and Sampling with the WaTerra Hand Pump, Revision 1
HWRB-8	Purging and Sampling with a Bladder Pump, Revision 2 Bladder Pump Equipment Diagram
HWRB-9	Low Flow Groundwater Purging and Sampling, Revision 3 Well Sampling Worksheet Low Flow Sampling Equipment Diagram
HWRB-10	Surface Water Sampling, Revision 1
HWRB-11	Soil Sampling
HWRB-12	Jar Headspace Technique for Field Screening Soil Samples, Revision 1
HWRB-13	Sediment Sampling, Revision 1
HWRB-14	Residential Water Sampling
HWRB-15	Decontamination, Revision 1
HWRB-16	Pore Water Sampling, Revision 1 Pore Water Sampling Worksheet
HWRB-17	Calibration of Field Instruments, Revision 1 Calibration Log
HWRB-18	Chain-of-Custody, Sample Handling & Shipping NHDES Laboratory's Chain of Custody Form

NHDES Preservation of VOCs in Soil Samples, March 2000

NHDES Vapor Intrusion Guidance, July 2006

NHDES Draft Evaluation of Sediment Quality Guidance Document, April 2005

## **MEASURING THE STATIC WATER LEVEL**

Electrical sounders such as the Slope Indicator model 51453 and the Solinst model 101P4 Water Levels are used for initial site work because they are intrinsically safe, simple to use and have a minimal potential for equipment contamination. The sounders consist of a conductivity cell at the end of a graduated wire, and a battery powered buzzer and light. When the cell contacts the water an increased conductivity completes a circuit and allows the current to flow to the alarm buzzer and the light.

The Slope model 51453 water level has a coaxial electrical cable with a probe that allows the user to measure water levels in small diameter wells such as piezometers. It has a sensitivity control which can be set near the low end (1 = lowest sensitivity) for very saline or contaminated water and towards the high end (10 = highest sensitivity) for very pure or fresh water. The depth to water can then be read from the graduations on the wire to 1/100 of a foot.

The Solinst model 101P4 water level has a flat polyethylene tape with stainless steel conductors, and a stainless steel probe which can operate in both cascading water and low conductivity water. The tape has permanent numerical markings every foot and 10th of a foot, with markings every 1/100 of a foot.

### **PROCEDURE:**

1. Turn the meter on.
2. Adjust sensitivity control.
3. Lower probe until the alarm and/or the light indicator goes "on."
4. Take measurement at the notch at the top of the PVC or well casing if there is no PVC. If well is not marked, take measurement from the hasp side of well.
5. Read and record measurements.
6. Thoroughly decontaminate the tape and probe following approved decontamination procedures.
7. Rewind reel.

## CALCULATION OF PURGE VOLUME

1. Determine the water level in the well.
2. If well depth is not already known from well history, determine the depth to the same location point that the water level was taken.
3. Measure the well diameter in inches.
4. Calculate one purge volume using the following equation, multiplying by number of purge volumes needed (3-5) or use conversion chart shown on the next page.

$$\text{One Purge Volume (Gallons)} = h \times 3.14(r/12)^2 \times 7.48 \text{ gal/ft}^3$$

$$\text{Volume} = h \times \pi \times r^2$$

$$\pi = 3.14 \text{ (a constant)}$$

$$r = \text{radius} = \text{diameter(in inches)}/2$$

$r/12$  converts radius to feet

$$h = \text{height(in feet of water)} = \text{depth of well} - \text{depth of water level.}$$

$$7.48 = \text{gallons in 1 cubic foot (ft) of water}$$

### **Groundwater Volume in Well Casings for Calculation of Purge Volumes**

$$\text{Purge Volume} = h \times 3.14(r/12)^2 \times 7.48 \text{ gal/ft}^3;$$

One Purge Volume = height of water x gallons/foot

$h$  = height (in feet) = depth of well - depth of water level.

Casing Diameter (Inches)	Gallons Per Foot	Gallons Per Foot X 3 Volumes	Gallons Per Foot X 5 Volumes	Height Of Water (Feet)	Purge Amount (Gallons)
<b>1.00"</b>	<b>0.04</b>	<b>0.12</b>	<b>0.20</b>		
<b>1.25"</b>	<b>0.06</b>	<b>0.18</b>	<b>0.30</b>		
<b>1.50"</b>	<b>0.09</b>	<b>0.27</b>	<b>0.45</b>		
<b>1.75"</b>	<b>0.12</b>	<b>0.36</b>	<b>0.60</b>		
<b>2.00"</b>	<b>0.16</b>	<b>0.48</b>	<b>0.80</b>		
<b>2.25"</b>	<b>0.21</b>	<b>0.63</b>	<b>1.05</b>		
<b>2.50"</b>	<b>0.25</b>	<b>0.75</b>	<b>1.25</b>		
<b>3.00"</b>	<b>0.37</b>	<b>1.11</b>	<b>1.85</b>		
<b>3.50"</b>	<b>0.50</b>	<b>1.50</b>	<b>2.50</b>		
<b>4.00"</b>	<b>0.65</b>	<b>1.95</b>	<b>3.25</b>		
<b>6.00"</b>	<b>1.47</b>	<b>4.41</b>	<b>7.35</b>		

## **A METHOD FOR DETERMINING AQUIFER STABILIZATION**

One method used to determine aquifer stabilization is to obtain three consecutive readings, 3-5 minutes apart and within the following stabilization limits:  $\pm 3\%$  for each of the parameters of temperature and specific conductivity;  $\pm 10\%$  for dissolved oxygen and for turbidity greater than 1 NTU; 0.1 for pH, and  $\pm 10$  for ORP. All parameters may not be required to determine stabilization.

### **PROCEDURE:**

1. Set up a sampling worksheet or chart to record time, purge volumes or flow rate, time, parameter readings etc.
2. All meters are calibrated daily prior to use according to manufacture. The calibration is then checked to ensure the calibration was successful. The meters may be recalibrated in the field as necessary. The calibration is checked again at the end of the day for drift. If the end of the day calibration is out of range, the data for that parameter must be qualified for use.
3. Readings may be taken:
  - Every 3-5 minutes until stabilization occurs
  - After each purge volume
  - After the final purge volume has been taken
  - Immediately before the well runs dry

## **SAMPLING WITH A BUCKET TYPE BAILER**

Bucket type bailers are tall narrow buckets equipped with a check valve on the bottom. This valve allows water to enter from the bottom as the bailer is lowered, then prevents its release as the bailer is raised.

This device is particularly useful when samples must be recovered from depths greater than the range (or capability) of suction lift pumps, when volatile stripping is of concern, or when well casing diameters are too narrow to accept submersible pumps. Samples can be recovered with a minimum of aeration if care is taken to gradually lower the bailer until it contacts the water surface and is then allowed to sink as it fills.

Bottom dispensing bailers are required for samples Volatile Organic Compounds (VOCs)

### **PROCEDURE FOR USE:**

1. Determine the water level in the well.
2. Calculate the purge volume.
3. Purge well.
4. Attach a pre-cleaned bailer to a dedicated cable (Teflon coated-stainless steel cable) or an unused line for lowering.
5. Lower bailer slowly until it contacts water surface.
6. Allow bailer to sink and fill with a minimum of surface disturbance.
7. Slowly raise bailer to surface. Do not allow the bailer line to contact the ground or Tyvek/clothing.
8. Tip the bailer to allow slow discharge from top to flow gently down the side of the sample bottle with minimum turbulence.
9. Repeat steps 4-8 as needed to acquire sufficient volume.

### **DECONTAMINATION**

Decontaminate bailer following approved decontamination procedures before reuse. Disposable sampling equipment shall be discarded after completing the sampling task and not reused.

### **EQUIPMENT BLANK**

Collect an equipment blank on all the parameters associated with the pumps use to ensure that the decontamination procedure is adequate.

## **PURGING WELLS WITH A CENTRIFUGAL PUMP**

A centrifugal pump is a type of suction pump, which uses positive displacement of water. The maximum suction head lift is approximately 26 feet. The centrifugal pump used by the HWRB has a gas driven motor with an impeller, a pull string start, a discharge port and a suction port. The discharge port has an intake, which has an optional strainer to prevent the entry of rocks, pebbles and cobbles. The typical pumping rate for the HWRB centrifugal pumps is 1-5 gal/min.

These suction pumps are not used for sampling because they may cause degassing, pH modification and loss of volatile compounds. They are only used for purging large volumes of water efficiently.

### **PROCEDURE FOR USE:**

1. Measure water level in well in feet.
2. Measure well diameter in inches.
3. Measure well depth or note it from site history. (*Note: the well depth should be checked periodically for accuracy.*)
4. Calculate purge volumes.
5. Set up the pump downwind from the well with the muffler turned away from the direction of the well, so it does not emit exhaust fumes in the direction of the well.
6. Attach dedicated (or disposable) tubing to inlet on pump, lowering other end of tubing into well.
7. Check to see if the pump has been primed. Do not operate the pump unless there is water in the tank. Operating the pump without sufficient water can cause the motor to overheat and burn out.
8. Position a 5- gallon bucket, marked in 1/2 or 1 gallon intervals, to catch the discharge from the discharge port.
9. Start the pump.
10. Count number of buckets filled until purge volumes has been reached. Note: If the flow rate (gallons/minute) is consistent, you may use a stopwatch to time the outflow from the discharge port into the 5-gallon bucket until purge volumes have been reached.
11. Turn off the pump and remove tubing.
12. Take samples with a bailer.
13. Decontaminate equipment following approved decontamination procedures
14. Properly dispose of non-dedicated tubing.



## **SAMPLING WITH A GRUNDFOS REDI-FLO 2 SUBMERSIBLE PUMP**

The Grundfos Redi-Flow 2 Submersible Pump is a submersible impeller pump that will fit inside a 2-inch or greater diameter well, operates at depths equal to the length of the motor lead (i.e. 100 feet for the HWRB Grundfos) and is powered by a gas-operated generator or other power supply.

### **PROCEDURE FOR USE:**

1. Determine water level in well and record.
2. Determine depth to screened interval in well.
3. Screw safety cable bracket into pump.
4. Attach safety cable to bracket (Teflon coated/stainless steel cable) or an unused line (polyethylene bailing twine) for lowering.
5. Cut tubing length to reach the middle of the screened area, adding an additional few feet to remain outside the well for discharging.
6. Attach tubing to safety cable bracket on pump with a small hose clamp. A check valve may be added to prevent backflow.
7. Slowly lower the pump and accompanying motor lead into the well by safety cable (not by the tubing).
8. Take another water level now.
9. Fit the motor lead plug from pump into the converter.
10. Start the generator. If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.

**NOTE: MAKE SURE THE GENERATOR IS RUNNING BEFORE YOU PLUG THE CONVERTER INTO IT.**

11. Plug the converter into generator.
12. Set the converter's speed dial near the middle of the dial (12 o'clock position).
13. Start the pump by pressing the start switch.
14. Adjust the pump flow by turning the speed dial.
15. At this point you can follow the low flow procedure, purge a minimum of 3 casing volumes or purge until selected parameters stabilize. Refer to site-specific sampling plan.
16. Take samples directly from tubing.
17. Turn off the pump.
18. Turn off the generator BEFORE removing the motor lead from the converter.
19. Remove pump from well by safety cable.

20. Disconnect tubing from pump. Dedicated tubing will either be left inside the well itself or left by the well according to the site-specific sampling plan. Non-dedicated tubing should be properly discarded.
21. Decontaminate pump, safety cable and motor lead.

## **DECONTAMINATION**

Dedicated equipment will not need decontaminating. However, non-dedicated equipment should be decontaminated prior to fieldwork and after each sampling location. Non-dedicated tubing should be properly discarded. The pump, including support cable and electrical wires that are in contact with the well will be decontaminated by one of the procedures listed below. If required, collect an equipment blank after the decontamination is complete.

The pump motor is filled with approximately 25 milliliters of contaminant free water. During operation, it is possible that a very small portion of this water could be replaced by the fluid being pumped. Therefore, there is a potential risk for cross contamination. A filling syringe is provided with each pump to replace the water with distilled/deionized water before each use. See operating manual for instructions.

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump; or the pump can be disassembled and flushed with the decontaminating solutions. The manufacturer recommends that if isopropyl alcohol is used in the decontamination process, it should be used sparingly; and that water-flushing steps should be extended to ensure that any sediment trapped in the pump is flushed out. The outside of the pump, the electrical wires and safety cable must be rinsed with the decontaminating solutions as well. The procedure is as follows:

1. Flush the equipment/pump with tap water.
2. Wash with a non-phosphate detergent.
3. Rinse with tap water.
4. Flush sparingly with an appropriate solvent (such as isopropyl alcohol), if necessary.
5. Flush one final time with distilled/deionized water.
6. Replace the water in the pump motor with distilled/deionized water.

## **EQUIPMENT BLANK**

Collect an equipment blank on all the parameters associated with the pumps use to ensure that the decontamination procedure is adequate.

## PURGING AND SAMPLING WITH THE WATERRA HAND PUMP

The WaTerra hand pump can operate at a maximum depth of 250 feet and can have a maximum flow of 2 gallon per minute. It can fit into a well with a one-inch inner diameter. The WaTerra hand pump is mainly used for purging wells and may be used for sampling for inorganics. **It is recommended that once the well is purged that a bailer or other method be used to procure samples for volatile organic compounds (VOCs).** The WaTerra pump may be used for the collection of semi-volatile or volatile organic compounds under certain circumstances if the results are flagged and the method noted.

The WaTerra Model 404 hand pump is an inertial pump which consists of a stainless steel level with a handle, a 5-/8 "D HPDE polyethylene riser tube, a delrin acetal thermoplastic standard foot valve (check valve with a 1" OD and 3"length (D-25) or check valve with a 0.625" OD with 1" length (D-16). The one-way check valve is lowered into the well and gradually raised. As the valve is pushed down water enters the tube. The water rises and discharges out of the tube.

### PROCEDURE FOR OPERATION:

1. Position the pump so that tubing does not hit the well cap or hasp of the well casing.
2. Then mount the WaTerra pump handle to the well casing by adjusting the clamps, which are located by the hold rings.
3. Sever the edge of the HPDE polyethylene tubing to create a groove for the foot valve with threading to attach.
4. Screw on the foot valve to the bottom of the tubing by turning the foot valve in a clockwise direction. The threading of the tubing should mesh with the tubing.
5. Check that the foot valve is secure by pulling on the foot valve. If the foot valve loosens, rethread it on to the tubing.
6. Securely hold the tubing and lower the end with the foot valve on it to the bottom of the well or to the middle of the screened interval. The tubing should be positioned vertically through the well and not coil.
7. Loop the tubing through the "holder" (clamps) in the handle.
8. Continue to loop the tubing below the handle and place it in the "hold ring". The discharge end of the tubing should not move freely. If it moves freely, it may splatter water.

9. The tubing should be horizontal, after it passes through the loop, and then positioned to dip down into a bucket for purge water.
10. Purge the well: Gradually lift the pump handle in a stroking motion. Do not jerk the pump.
11. Measure the flow into a bucket marked with gallon intervals.
12. Collect the sample: Reduce flow and hold tube, so that it discharges into the sample container.
13. Dismount the WaTerra hand pump.
14. Pull out the tubing and detach foot valve. The foot valve may be decontaminated. The tubing should be properly discarded. Note: Tubing and foot valve may be dedicated to the well and replaced or remain in well after sampling, as the case may be.
15. Rinse a stainless steel or Teflon bailer at least three times in the well and sample for volatile organic or semi-volatile organics.
16. Decontaminate equipment following approved decontamination procedures. Disposable sampling equipment shall be properly discarded after completing the sampling task.

## **PURGING AND SAMPLING WITH A BLADDER PUMP**

### **PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to give general instructions on sampling with a bladder pump. This procedure may be used in conjunction with the Low Flow Groundwater Purging and Sampling SOP (#HWRB-9) in the QAPP. A diagram has been provided to show the equipment setup for low flow sampling using a bladder pump with an air compressor and a marine battery; however, the diagram may be modified to use the bladder pump with a nitrogen tank and gas regulator, with or without the multi-parameter and turbidity meters as specified in the Sampling and Analysis Plan (SAP).

### **BLADDER PUMP CONSTRUCTION**

The pump consists of four basic parts: 1) Upper check valve assembly, 2) Bladder assembly, 3) Pump casing, and 4) Lower check valve assembly. It is connected to a controller, which allows the operator to adjust the pumping rate.

A flexible bladder with a check valve at either end is suspended inside a rigid chamber. During sampling the rigid chamber is pressurized with gas, typically compressed air. This hydrostatic pressure squeezes the bladder causing the closure of the lower check valve forcing the water in the bladder through the upper check valve and into the discharge tubing. This cycle is then repeated until the sample is recovered.

### **EQUIPMENT AND MATERIALS:**

**The following is equipment and materials that are generally used with a bladder pump, including equipment typically used with the low flow sampling method:**

- Bladder pumps (preferably dedicated bladder pumps);
  1. The length, capacity, and placement of the pump in the well, shall be selected to maximize the filling of the pump's bladder.
  2. The bladder's capacity shall be large enough (over 70 milliliters, preferably 100 milliliters) to ensure filling a VOA vial in one pulse;
- Compressed gas power source (non gasoline powered): either a compressed nitrogen tank with a gas regulator or a marine battery operated air compressor (i.e. QED Model 3020 Electric Compressors).
- Controller (i.e. QED Bladder Pump Controller Model MP-10 or Model 400).

**The controller shall have a manual control button and be capable of adjusting the flow rates as low as 50 ml/minute.**

- Appropriate tubing:  
Sized as recommended by the manufacturer or specified in the SAP.  
Typically Polyethylene is used unless sampling for semi-volatiles, in which case Teflon tubing for both air and sample lines are required.  
Pharmaceutical or surgical grade silicon tubing, size #15 (3/16" x 3/8" x 3/32") may be used from the well cap to the three way stopcock and from the stopcock to the input of the multiparameter meter.
  - Electronic water level meter measured to the nearest one-hundredth of a foot (0.01');
  - An appropriate sized graduated cylinder, (i.e. 250 ml, measured in 10 ml increments) to accurately measure the flow in ml/min.
  - A stop watch to accurately measure the flow in ml/min.
  - Multi-Parameter Water Quality Meters (YSI 600XL or 6820; or QED MP20) with a 250 ml or less internal volume transparent flow through cell that measures the following parameters to use with the low flow sampling technique:
    - Temperature °C
    - Specific Conductivity in  $\mu\text{S}/\text{cm}$
    - Dissolved Oxygen (DO) in mg/L
    - pH that calibrates using 3 standards (pH 4, 7 and 10)
    - Oxidation Reduction Potential (ORP) in mV
- When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out;
- Hach 2100P Portable Turbidity Meter using the following standards: < 0.1, 20, 100 and 800 NTUs for calibrating;
  - A three way stopcock to divert sample flow for turbidity reading:  
i.e. Nalgene three-way stopcock with a plug bore of 4 mm (or 0.157 in) NNI No. 6470-0004 VWR catalog No. 59097-080;
  - The manufactures instruction manuals for all equipment;
  - Appropriate calibration standards for the multiparameter and turbidity meters including; 100% water-saturated air chamber and 0 mg/L DO solution for DO, Zobell solution for ORP, two different specific conductance standards (one low [i.e. 447  $\mu\text{S}/\text{cm}$ ] to calibrate and one higher [i.e. 718 or 1413  $\mu\text{S}/\text{cm}$ ] to check the calibration), 4, 7, 10 units pH, and < 0.1, 20, 100 and 800 NTUs for turbidity. Extra DO membranes in case of breakage.
  - DI water / tap water;
  - Plastic sheeting;
  - Paraphernalia to adequately shade and protect personnel, equipment, tubing and sample containers from the elements and to prevent temperature variations in the readings, bubbles forming in the tubing, and the acid preservative in the sample containers from volatilizing;

- Decontamination equipment and supplies;
- Logbook, pencil/pen/sharpeners, calculator;
- Field-data sheets, sample labels, chain-of-custody records and seals;
- Sample containers, preserved as necessary, cooler and ice;
- Plastic bags, bubble wrap, to protect and store samples;
- Appropriate keys for gates and wells;
- Appropriate health and safety gear and an approved site-specific Health & Safety Plan;
- Trash bags to containerize solid waste;
- Toolbox to include wrenches, pliers, , screw drivers, 25' measuring tape, a sharp knife with a locking blade, wire strippers, hose connectors, Teflon tape, and duct tape, at a minimum);
- Well construction data, location map, field data from last sampling event if available;
- Site Specific SAP which includes well logs, map and other project-specific information; and
- Quality Assurance Project Plan (QAPP)
- A diagram to show how the equipment should be set up.

## GENERAL OPERATING PROCEDURE

Manufacturer's instruction manuals should be followed.

1. Set up the equipment according to the diagram provided, modifying as necessary.
2. Lower pump to desired depth in well after making all connections according to the assembly instructions. Note: Some pumps may be dedicated to the well and be installed permanently.
3. If parameter readings are to be collected, the equipment shall be calibrated according to the Calibration of Field Equipment SOP in the QAPP.
4. Activate the gas source, which activates the pneumatic controller.
5. Adjust pressure regulator for the appropriate pump depth. Note: In general, it is not recommended to exceed 125 PSI, as higher pressures may create hazardous conditions and void system warranties. Refer to the manufacturer's instruction manual for the specific recommendations.
6. Vent the moisture from the controller filter regulator before starting, periodically during pumping and at the end if it is not done automatically.
7. Adjust the "refill" and "discharge" controls (cycles) according to well depth and pressure to optimize purging and sampling rates. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. **Purging rates shall not be below 50 milliliters per minute.**

**The refill and discharge rates shall be adjusted to collect a VOA vial in one pulse.**

8. Purge the well (according to the low flow sampling procedure if appropriate).
9. Collect samples. If the pumping rates are too fast, there may be air bubbles. A decreasing of speed from the control box may be required when sampling the well.

**If the flow rate is such that you cannot fill a 40 milliliter VOA vial in one pulse of the pump, the manual sample button on the controller shall be used to collect a VOA vial in one pulse.**

Follow the manufacturer's instructions on using the manual control button. Allow the bladder to refill completely before discharging the sample.

Samples must be collected before the flow cell and the three way stopcock. This will be done by disconnecting the flow cell and the three way stopcock so that the sample is collected directly from the pump tubing. VOCs samples should be collected first and directly into pre-preserved sample containers. All sample containers should be filled by allowing the discharge to flow gently down the inside of the container with minimal turbulence.

10. When finished sampling, deactivate the gas source.
11. Disconnect equipment, as needed.
12. If the pump is not dedicated to the well, it must be removed and decontaminated.

## **DECONTAMINATION**

Decontaminate equipment following approved decontamination procedures. Dedicated equipment will not need decontaminating. However, non-dedicated equipment shall be cleaned prior to fieldwork and decontaminated after each sampling location.

**NOTE: If you must disassemble the pump please see the operating manuals on each specific pump for instructions on disassembling. Some models are not designed to be disassembled in the field.**

Disposable sampling equipment (i.e. non-dedicated tubing, etc) shall be discarded after completing the sampling task.

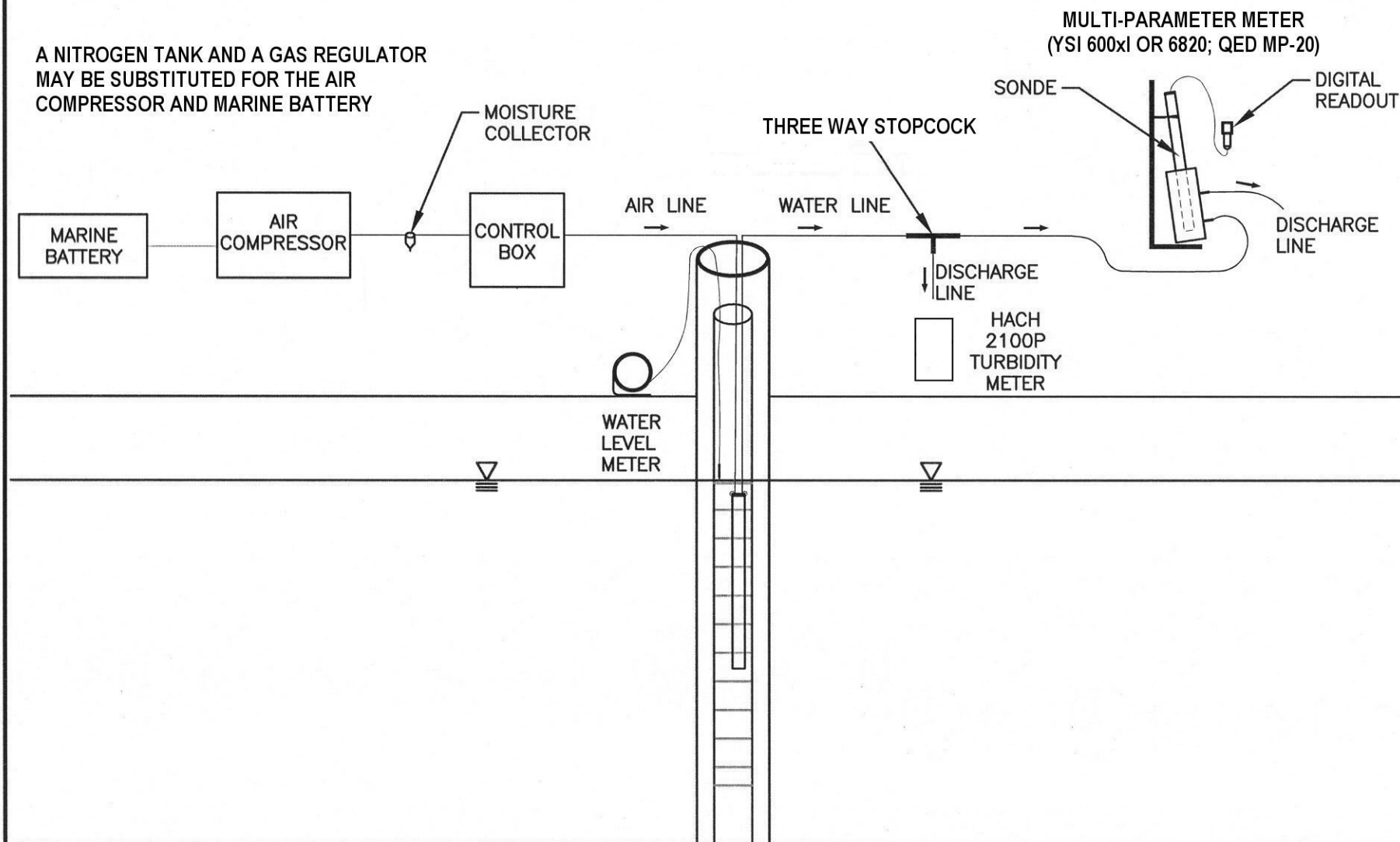
## **EQUIPMENT BLANK**

Collect an equipment blank on all the parameters associated with the pumps use to ensure that the decontamination procedure is adequate.



# BLADDER PUMP SAMPLING DIAGRAM

THIS DIAGRAM SHOWS THE BLADDER PUMP SET UP FOR LOW FLOW SAMPLING



## **LOW FLOW GROUNDWATER PURGING AND SAMPLING**

### **SCOPE AND APPLICATION**

This Standard Operating Procedure (SOP) provides a general framework for collecting groundwater samples that are indicative of mobile organic and inorganic loads at ambient flow conditions. We accomplish this by: low pumping rates, negligible water level draw down and stabilization of water quality parameters; emphasizing the need for low pumping rates in order to collect samples with minimal alterations to water chemistry. This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids.

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which ideally should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permeability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations.

Low Flow Sampling (LFS) includes a purge option, a modified purge option and a no-purge option. The purge option for LFS involves pumping the well at a rate approaching ambient groundwater flow in order to minimize disturbance of the sampling zone and mixing of the riser water. Field parameters are monitored during purging until readings have stabilized; at this point (theoretically), groundwater entering the pump intake represents formation water and the sample is collected.

In low permeability formations or poorly installed monitoring wells it may not be possible to collect groundwater samples using the specified purge techniques. In such instances, the modified or no-purge options should be evaluated and approved by the project manager. See the options at the end of this SOP.

## **EQUIPMENT:**

- **Pumps:** The pump selected must have capabilities of adjusting the flow rate without the use of flow restrictors. Adjustable rate, positive displacement pumps (*e.g.*, centrifugal or bladder pumps constructed of stainless steel or Teflon) and peristaltic pumps (see project manager for restrictions) may be used. The Bureau recommends the use of dedicated equipment, where possible, for long term monitoring plans. Pumps capable of pumping at 50 ml/minute may be required. See the site specific sampling and analysis plan for pump requirements.

### **Notes on pumps:**

**Getting down to 50 ml/minute may require the purchase of a different peristaltic pump head from the one that comes standard with the peristaltic pump.**

### **If using a bladder pump:**

- 1. The size, capacity of the pump, and placement in the well shall be selected to maximize the filling of the pump's bladder.**
  - 2. The bladder's capacity shall be large enough (over 70 milliliters) to fill a VOA vial in one pulse;**
  - 3. The control box shall have a manual control option, and**
  - 4. The refill and discharge rates shall be adjusted to collect a VOA vial in one pulse.**
- **Appropriate tubing:**

The Hazardous Waste Remediation Bureau (HWRB) requires that a fiberglass measuring tape or other accurate measuring device be used when measuring and installing tubing.

Teflon, Teflon lined polyethylene or polyethylene; cut to reach the appointed sampling depth, adding an additional length as necessary to remain outside the well for discharging. One-quarter (1/4) inch inside diameter (ID) tubing is the standard size used in conjunction with the low flow technique, however, three-eighths (3/8) inch ID tubing may also be used with project manager approval. Smaller diameter tubing (less than 1/4 inch ID) is not generally recommended. If sampling with a bladder pump, use the size tubing recommended by the manufacturer.

Teflon tubing is required for collecting semi-volatiles samples. If semi-volatile samples are collected with a bladder pump, both the air and sampling lines shall be made of Teflon.

Pharmaceutical or surgical grade silicon tubing shall be used with peristaltic pumps in variable sizes such as the following in ID x OD x Wall: #16 (1/8 x 1/4 x 1/16), #15 (3/16" x 3/8" x 3/32), #14 (1/16 x 3/16 x 1/16).

- **Electronic water level meter measured to the nearest one-hundredth of a foot (0.01').**
- **Power source (12 volt, deep cycle marine battery or other battery such as a garden tractor battery; air compressor; nitrogen tank; etc). The HWRB prefers the use of non gasoline-powered equipment. If a gasoline-powered source is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.**

- Multi-Parameter Water Quality Meters (i.e. YSI 600XL or 6820; or QED MP20) with a 250 ml or less internal volume transparent flow through cell. The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. The meter shall measure the following parameters to use with the low flow sampling technique:

Temperature °C

Specific Conductivity in  $\mu\text{S}/\text{cm}$

Dissolved Oxygen in mg/L

pH that calibrates using 3 standards (pH 4, 7 and 10)

Oxidation Reduction Potential (ORP) in mV

- Portable Turbidity Meter with a calibration range from 0.00 to 800 (1000) NTUs (i.e. Hach 2100P Portable Turbidity Meter using the following standards: < 0.1, 20, 100 and 800 NTUs for calibrating). Turbidity must be taken at a point before the flow-through cell and from a meter separate from the flow through cell apparatus.
- A three way stopcock to divert sample flow for turbidity reading:  
(i.e. Nalgene three-way stopcock with a plug bore of 4 mm (or 0.157 in) NNI No. 6470-0004 VWR catalog No. 59097-080.)
- The manufactures instruction manuals for all equipment.
- Appropriate calibration standards for the multiparameter and turbidity meters including; 100% water-saturated air chamber and 0 mg/L DO for DO, Zobell solution for ORP, two different specific conductance standards (one low to calibrate and one higher to check the calibration), 4, 7, 10 units pH, and < 0.1, 20, 100 and 800 NTUs for turbidity. Extra DO membranes in case of breakage.
- A graduated cylinder, (i.e. 250 ml graduated cylinder, measured in 10 ml increments) to accurately measure the flow in ml/min. Make sure that the graduated cylinder is the appropriate size for the flow rate.
- A stop-watch to accurately measure the flow in ml/min.
- Plastic sheeting.
- Distilled water / tap water.
- Paraphernalia to adequately shade equipment and tubing to prevent temperature variations in the readings, bubbles forming in the tubing, and to prevent the acid preservative in the sample containers from volatilizing. Paraphernalia should also be designed to protect both personnel and equipment from other elements including rain, wind, and etcetera.
- Decontamination supplies if appropriate (for example, non-phosphate detergent, distilled/deionized water, appropriate solvent, etc.).
- Logbook(s) and other forms (i.e. Field-data sheets, sample labels, chain-of-custody records and seals, field work sheets, well purging forms, calibration logs).
- Sample containers, preserved as necessary, sample labels, cooler and ice.

- Plastic bags, bubble wrap, to protect and store samples.
- Trash bags to containerize solid waste.
- Toolbox to include wrenches, pliers, screw drivers, 25' measuring tape, a sharp knife with a locking blade, wire strippers, hose connectors, Teflon tape, and duct tape, at a minimum).
- Well/Site keys.
- Well construction data, location map, field data from last sampling event if available.
- Site Specific Sampling and Analysis Plan (SAP) which includes well logs, map and other project-specific information.
- Quality Assurance Project Plan (QAPP).
- Appropriate health and safety gear and an approved site-specific Health & Safety Plan.
- PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes and provide qualitative field evaluations.
- A diagram to show how the equipment should be set up.

#### **PREPARATION:**

Prior to conducting a LFS event, information regarding well construction, development, and water level records for each well to be sampled should be obtained and reviewed to determine the appropriate pump to be used, the location of the intake, and the potential groundwater recharge rate of the well. If this information is not available, a reconnaissance should be made prior to the actual sampling event to determine well depth, water level, length of screen, etc., and to possibly perform a pump test to determine the recharge rate of the well. Additionally, wells that have not been sampled in years should be redeveloped prior to conducting the actual sampling event, if possible.

Cold weather considerations must be factored into a low-flow sampling plan.

#### **PRELIMINARY PROCEDURES:**

- A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total depth (to 0.01 ft.) be measured the day before in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance. It may not be possible to measure the depth of the well if dedicated bladder pumps are used. If that is the case, the depth of the well should be measured when the pump is removed for maintenance, if there is evidence of high turbidity, or as determined in the SAP.

- In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, calibrated, tested and inspected according to the manufacturer's instructions. The manufacturer's instruction manuals for field equipment shall be on site during each sampling event.
- All instruments will be successfully calibrated once by the sampling team prior to the sampling event to ensure that the equipment is working properly.
- The instruments shall be calibrated at the beginning of each sampling day at the Site using the appropriate solutions. The calibration will be checked in the run mode after the morning calibration has been completed to ensure that the calibration was successful. The calibration will be checked at the end of the day in the run mode to verify the accuracy of the instrument readings throughout the day. All calibration data shall be recorded on the calibration log. In addition, should any erratic or suspect readings occur between calibrations, the instrument shall be recalibrated in order to ensure that representative measurements are obtained. Refer to the Calibration of Field Instruments SOP in the QAPP for specific calibration procedures and calibration log.
- Check well for security damage or evidence of tampering, record observations.
- Remove well cap. Immediately measure VOCs at the rim of the well with a PID or FID instrument if required in the SAP or Health and Safety Plan and record the reading in the field logbook.
- Set up equipment according to the attached Low Flow Sampling Diagram. This diagram shows the low flow setup using a bladder pump; however, the diagram may be modified in the SAP to show the appropriate pump.

#### **SAMPLING PROCEDURE:**

1. Measure and record the depth to water (to 0.01 ft) before any disturbance to the well. Care should be taken to minimize suspension of any particulates attached to the sides.
2. Install sampling pump or tubing if necessary. It is highly preferable that sampling tubing and pumps be dedicated to wells. However, in situations where dedicated equipment is not used, field staff will lower equipment (i.e., pump, safety cable, tubing and electrical lines) slowly into the well so that the pump intake is located at the center of the saturated screened interval or at a location designated by the project manager. Great care must be taken to minimize the disturbance of particulates that can greatly extend the purge time by increasing turbidity. If possible keep the pump intake one to two feet above the bottom of the well to avoid disturbing any sediment on the bottom. The pump's safety cable shall be secured to the well casing (or PVC stick-up) to minimize movement.
3. Measure and record the water level again with the equipment in the well before starting the pump.
4. Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown. It is best to concentrate on the flow rate and water level stabilization in the beginning. Air captured in the

tubing can usually be removed by elevating the discharge tube and pump to allow the air to continue rising until discharged with the water. Subsequent sampling rounds will probably have intake settings and extraction rates that are comparable to those used in the initial sampling rounds; check previous data sheets to assist in well set up and establishing flow rates.

5. Monitor and record the water level, draw down, pumping rate, any adjustments, and the parameters (pH, turbidity, specific conductance, temperature, dissolved oxygen and oxygen reduction potential) every five minutes or as appropriate. **Readings shall NOT be taken less than five minutes apart.** Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to avoid drawdown and to ensure stabilization of monitoring parameters. **Pumping rates shall not be less than 50 ml/minute.** If a constant water level cannot be maintained, the modified and no purge options should be evaluated and approved by the project manager. See modified options at the end of this SOP.

The well is considered stabilized and ready for sample collection once all the parameter values remain within the required specifications for three consecutive readings taken at 5 minute intervals.

- **Temperature (°C) +/-3%**  
Values are typically rounded to the nearest whole number.
- **Specific Conductivity (µS/cm ) +/-3%**  
Values are typically rounded to the nearest whole number.
- **Dissolved Oxygen +/-10%**  
Values are typically rounded to the nearest whole number.
- **pH +/- 0.1 unit**  
Values are typically rounded to one decimal point.
- **ORP +/- 10 millivolts**  
Values are typically rounded to the nearest whole number.
- **Turbidity +/-10% for values greater than 1 NTU**  
Values are typically rounded to the nearest whole number.  
Values less than one (1) are typically reported as <1.

**Note: The project manager may set a limit on the amount of time allowed at each well due to financial, manpower and/or other constraints. In that case, sample collection would occur after the specified time has elapsed and it would be noted on the field sheet that the time limit had been reached before stabilization occurred.**

**In general there is a two hour time limit for each well unless specified differently in the site specific SAP.**

- 6 Collect samples. Samples for laboratory analyses must be collected before the flow cell and the three way stopcock. This will be done by disconnecting the flow cell and the three way stopcock so that the sample is collected directly from the pump tubing. VOCs samples should be collected first and directly into pre-preserved sample containers. All sample containers

should be filled by allowing the discharge to flow gently down the inside of the container with minimal turbulence. Sample containers should be wiped dry.

7. After collection of the samples, any tubing used may either be dedicated to the well for resampling or properly discarded. Dedicated tubing should be secured to the inside of the well.
8. Secure the well.
9. All non-dedicated equipment must be decontaminated following approved decontamination procedures.

## **PROCEDURE EVALUATION AND MODIFICATIONS**

Due to site conditions, sample variability, manpower, financial and/or other constraints, the HWRB project manager, in consultation with the QA Coordinator, may generate modifications to this procedure such as time limitations, equipment used, alternative sampling techniques, etc.

The purpose of the LFS procedure is to sample the groundwater from the surrounding aquifer. If a well is not receiving sufficient recharge from the formation, the water level in the well will drop as pumping continues. This means that the discharge water could contain a significant percentage of stagnant water from the well casing. As the percentage of casing water increases, the representativeness of the sample decreases. Monitoring wells with slow recharge rates may not be capable of being pumped at a continuous rate (even as low as 50 ml/min). In this event, an alternative sampling technique should be considered.

The LFS procedure may be modified to meet the data quality objectives for the sampling event. In long-term monitoring events it may be possible to reduce the field parameter list after baseline information is obtained over the first year or two. Careful consideration should be given to the purpose of each parameter used in the procedure. Each parameter may have some importance that extends beyond the measurement for equilibrium.

## **MODIFIED PURGE PROCEDURE**

This procedure may be used in cases where the recharge rate of the well is very low and zero or minimal drawdown cannot be achieved.

### **Purging**

The project manager shall specify the location of the inlet.

- If the water level is above the top of the well screen or open interval:  
Purge until the water level reaches just above the top of the well screen or open interval; or until the limit of the pump capacity has been reached as long as the water level is still above the top of the well screen or open interval.
- If the water level is below the top of the well screen or open interval:  
Purge until the water level reaches the pump intake or until the limit of the pump capacity has been reached.



### **Recovery and sampling**

Sampling shall commence as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples.

### **NO-PURGE OPTION**

The theory of no-purge sampling is that the water in the screened zone is in equilibrium with the aquifer and the water in the riser portion of the well is not. The goal is to sample only the water in the screened zone and to minimize any mixing with the water in the riser.

In certain low permeability formations it may not be possible to maintain a zero drawdown at low flow rates (at or near 50 ml/min.). In these formations the only option may be to obtain a groundwater sample without purging.

### **No-Purge Option Procedure**

The same principle applies to the no-purge option that applies to the purge option. Dedicated equipment is required to properly complete this procedure (to eliminate any additional mixing of the water in the riser with the water in the screen).

- The pump intake must be in the screened zone, at or slightly above the midpoint of the screen, or at a location designated by the project manager.
- Calculate the volume of water standing in the discharge line.
- Turn on the pump at the lowest possible flow rate.
- Purge the volume of water that was standing in the discharge line.
- Immediately begin sample collection after the discharge line is purged.

### **DOCUMENTATION**

A field log must be kept each time ground water monitoring activities are conducted in the field; the HWRB Well Sampling Worksheet is the approved form for use by staff. The field log/sampling worksheet should document the following at a minimum:

- Job name;
- Well identification, condition of well;
- Name of sample collector(s);
- Date;
- Weather conditions;
- Well depth;
- Screen length;
- Static water level;
- Pumping rate, or flow rate including units;

- Any adjustments to the flow rate;
- Time of all measurements;
- Water level at the specified pumping rate;
- Drawdown in feet;
- Cumulative drawdown;
- Indicator parameters values;
- Time of sample collection;
- Parameters requested for analysis;
- Any comments;
- Notation of reaching time limit; and
- Notation of which stabilization parameters did not stabilize after two hours of purging (if any).

## **DECONTAMINATION**

Decontaminate equipment following approved decontamination procedures. Dedicated equipment will not need decontaminating. However, non-dedicated equipment shall be cleaned prior to fieldwork and decontaminated after each sampling location. Non-dedicated tubing should be discarded.

## **EQUIPMENT BLANK**

Collect an equipment blank on all the parameters associated with the pumps use to ensure that the decontamination procedure is adequate.

## **REFERENCES**

USEPA Region I, 1996; Low-Stress (Low-flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells, Revision 2, July 30, 1996

# Well Samnpling Worksheet

Date :

**Well ID :** \_\_\_\_\_

Field Personnel

Purging Start Time : \_\_\_\_\_

Purging Device (pump type) \_\_\_\_\_

Total Purge Volume (ml): \_\_\_\_\_

Well Depth (ft): \_\_\_\_\_

Parameter Stabilization: (Circle) **Yes** / No

Screen Length in ft. \_\_\_\_\_

Two Hour Time Limit Reached ? (Circle) Yes / No

Depth to GW (ft): \_\_\_\_\_ From: \_\_\_\_\_

Time at Sample Completion: \_\_\_\_\_

Pump Intake set (ft): \_\_\_\_\_ From: \_\_\_\_\_

Signature: \_\_\_\_\_

### Weather Conditions and Notes:

[illegible]

Notes: All depths in feet below top of PVC unless specified.

NR = No Reading

**Tubing Factors:** Milliliters to purge standing water in tubing

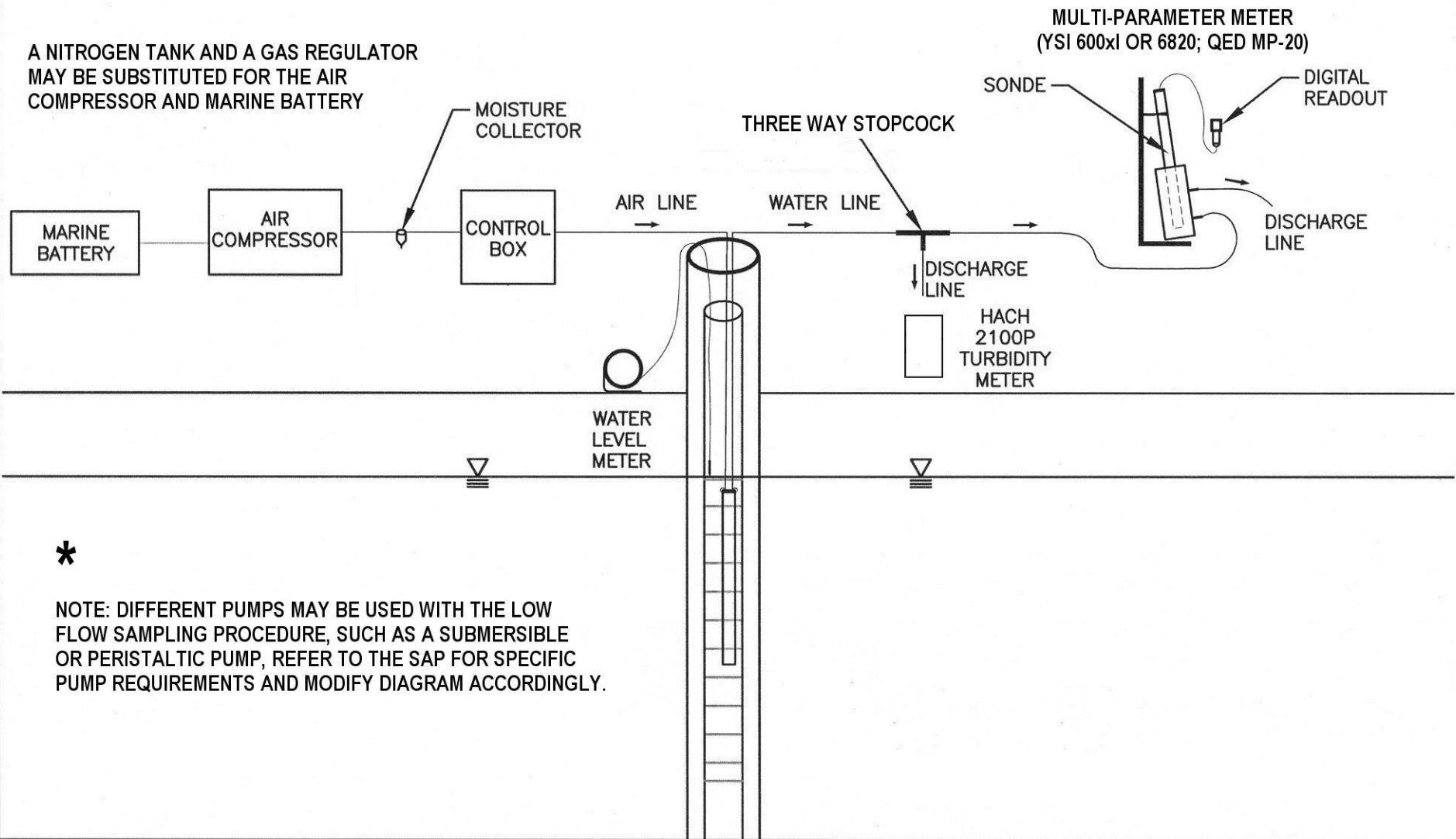
1/2" ID: height in ft.x 38.59 = ml needed

1/4" ID: height in ft.x 9.64 = ml needed

1/8" ID: height in ft. x 2.41 = ml needed

# LOW FLOW SAMPLING DIAGRAM

THIS DIAGRAM SHOWS THE BLADDER PUMP SET UP FOR LOW FLOW SAMPLING\*



## **SURFACE WATER SAMPLING PROCEDURE**

### **PURPOSE**

The purpose of the Standard Operating Procedure (SOP) is to obtain surface water samples for analysis that are representative of environmental conditions at the location sampled.

### **PREPARATION**

If a sample cannot be obtained safely, the sample should not be collected at all and the circumstances shall be documented in the sampler's field book. In general this procedure requires a minimum of two sample personnel for safety concerns.

Weather conditions and data quality objectives should be considered and documented in the Sampling and Analysis Plan (SAP) when planning a surface water sampling event. Determine what conditions the sampling event should occur in: “dry” or “wet” and define those terms prior to the sampling event.

When collecting surface water, pore water, and sediment samples in the same location, sampling should occur in that order, surface water samples first, then pore water samples and finally sediment samples.

### **EQUIPMENT**

The following equipment is typically used in collecting surface water samples:

- Appropriate health and safety gear and an approved site-specific Health & Safety Plan;
- Waders;
- Sample containers, preserved as necessary, cooler and ice;
- Plastic bags to protect and store samples;
- Site Specific SAP which includes well logs, map and other project-specific information;
- Field data from last sampling event if available;
- Field data sheets, sample labels, chain of custody forms;
- Logbook, pencil/pen/sharpeners, calculator;
- The manufacturer's instruction manuals for all equipment;
- Decontamination supplies/equipment;
- Distilled (deionized) water;
- Paper towels;
- Stream staff/gage or similar measuring device;

- Toolbox to include general items such as large and small wrenches, pliers, screw drivers, 25' measuring tape, hose connectors, sharp knife (locking blade), duct tape, at a minimum;
- Camera to take digital pictures.
- Pre-decontaminated glass jar or stainless steel container to use as an intermediary container to fill pre-preserved VOC vials. Include a minimum of one spare if using glass;
- Fifty (50) cc syringes (plus spares) if collecting dissolved metals;
- 0.45 micron filters to fit over the end of the syringes for dissolved metals. Have enough filters on hand to collect the volume required by the lab. Keep in mind that the turbidity of the water may clog the filters at an unknown rate;
- A multiparameter meter for measuring pH, Specific Conductivity, Temperature, Oxidation Reduction Potential (ORP) and Dissolved Oxygen (DO); the same make and model as used for groundwater sampling, if applicable;
- A probe guard for the multiparameter meter to take in-situ parameter readings;
- A Turbidity Meter; the same make and model as used for groundwater sampling if applicable;
- Appropriate calibration standards for the two meters, if water quality parameters are collected; and
- Peristaltic pump and tubing, if required for subsurface sampling.

## **GENERAL PROCEDURE**

Using a stream staff/gage or similar measuring device, measure the depth of water from the bottom of the streambed to the surface of the water in feet and record the measurement. If water quality parameters such as pH, Specific Conductivity, Temperature, ORP and DO are required, they shall be collected in-situ. Turbidity shall be collected using a separate meter. The instruments shall be calibrated in the field prior to use, according the Calibration of Field Instruments Standard Operating Procedure (SOP) in the QAPP. Parameter readings shall be collected prior to collecting analytical samples.

Surface water samples should be collected from the bank if possible for safety and ease of sampling. If the stream/creek/water body must be waded to collect samples, the water should not exceed three feet in depth. Surface water samples to be collected from the same water body should be collected sequentially from downstream to upstream sample locations. Sample locations will be approached from the downstream side to minimize bottom sediment disturbance, and the sample should be collected up stream of the sampler. Water samples collected from a boat shall be collected from the bow or upstream side of the boat, away from the motor, with extreme care taken to avoid contamination of the sample.

Samples may be collected directly into the sample containers if the sample calls for un-preserved sample containers. If the sample containers are pre-preserved, the sample must be collected using an appropriate intermediate container such as a glass jar or stainless steel beaker. Dissolved metals samples shall be collected using a syringe and an appropriate filter.

Collection of floating debris and surface skim shall be avoided. The mouth of the container shall be facing upstream and the container will be slowly submerged just beneath the surface of the water, unless specified otherwise in the SAP. If surface water is collected with an intermediate container, it will be immediately transferred to the appropriate sample containers and the device will then be decontaminated before reuse. Once sampling containers are filled with the appropriate amount, they are capped and cleaned to remove any potential residue.

Subsurface water samples may be collected using an appropriate pump and tubing, extending the tubing to the sampling depth; or with a device made of the appropriate materials designed for depth-specific sampling. This information shall be specified in the SAP.

## **QUALITY ASSURANCE SAMPLES**

Collect appropriate quality assurance samples as specified in the SAP.

At least one duplicate sample should be collected per analysis.

Equipment blanks should be collected on non-disposable equipment to ensure that the equipment is clean and the decontamination procedure is adequate (i.e. syringes, filters, glass or stainless steel containers, etc.).

## **DECONTAMINATION**

Decontaminate equipment following approved decontamination procedures.

Disposable sampling equipment shall be discarded after completing the sampling task and not reused.

## **EQUIPMENT BLANK**

Collect appropriate equipment blanks for all the parameters associated with the equipment used to ensure that the decontamination procedure is adequate.

## **DOCUMENTATION**

In general all data and sampling information will be documented as recorded as specified in the SAP. Specific reporting of these sampling events may include, but is not limited to, the following information:

1. Past 7 days of local meteorological data showing a minimum of daily precipitation totals and barometric pressure;

2. Water depths at the sampling locations;
3. Any water quality parameter readings taken;
4. General physical description of the samples and sampling locations; and
5. Digital photographs of sampling locations including one or more of the larger surrounding area.



## SOIL SAMPLING PROCEDURE

This Standard Operating Procedure (SOP) applies to the collection of surface and subsurface soil samples for contaminant analysis.

All sampling equipment will be decontaminated prior to being used for collecting samples. Sample collection activities shall generally proceed progressively from the suspected least contaminated area to the suspected most contaminated area when possible. Stage all equipment and supplies on plastic sheeting, or equivalent, to prevent contact with potentially contaminated surfaces.

**Note: Samples for VOC analysis must follow New Hampshire Department of Environmental Services “Final Policy Preservation of VOCs in Soil Samples” SOP dated March 2000, which is found in the QAPP.**

A variety of soil sampling tools, typically made of stainless steel, are available for collection of soil samples (e.g., hand augers, split spoons, coring devices, scoops, spoons, etc.). Boreholes for subsurface soil samples may be advanced by hand boring devices (hand augers), portable powered augers, drilling rig, or hammering equipment. This procedure primarily references hand augers but is applicable to other soil sampling equipment.

For surface soil samples (i.e., 0-6”, 0-12”, etc.): using a stainless steel hand auger or other soil sampling device (which has been decontaminated), auger or core into the material which is being sampled, to the specified depth, and retrieve the sample.

For subsurface soil samples: using a hand auger or other boring or drilling device (which has been decontaminated), advance the borehole to the appropriate sampling depth. Prior to collecting the sample, remove and/or minimize cuttings/cavings from the borehole to avoid collection of material that is not from the sampling interval. Then use a decontaminated hand auger or sampling device, such as a thin walled tube or split spoon sampler, to collect the sample. After retrieving the sampler, trim the upper portion of the sample to remove any cuttings or cavings that may be present with the sample.

If using a backhoe, shovel or other equipment to remove soil from the excavation, use a stainless steel trowel to collect soil that has not come into contact with the tool used for excavation and place it in the pan.

Place the sample into a stainless steel or glass pan. Collection of plant or foreign material that is not part of the sample should be avoided. Continue this procedure until the appropriate volume of sample is obtained.

With the exception of VOC samples, it is extremely important that the sample be mixed and homogenized as thoroughly as possible to ensure that the sample is representative of the sampled material. A common method of mixing is referred to as quartering. Using a decontaminated

stainless steel trowel, the sample in the sample pan is divided into quarters. Each quarter is mixed, and then all quarters are mixed into the center of the pan. This procedure is followed several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material.

Note; If samples are predominantly moist and clayey, extra effort may be necessary to produce a homogenous mixture.

Fill and cap the remaining sample containers. Clean the exteriors of the containers to remove any potential residue.

Decontaminate equipment following approved decontamination procedures. Disposable sampling equipment shall be discarded after completing the sampling task and not reused.

## JAR HEADSPACE TECHNIQUE - FIELD SCREENING SOIL SAMPLES

The purpose of this document is to describe the procedure for field screening volatile organic content of soils using a “Jar Headspace Technique” (JHT) with a photoionization detector (PID) or a flame ionization detector (FID). This methodology is not to replace actual laboratory analysis; it is to provide a screening tool in the field for determining “hot spots” and other areas of high or low concentrations of VOCs presence in soil, or for when choosing samples from a site for laboratory analysis.

In conducting this procedure, a soil sample is placed in a sealed jar or polyethylene bag and the volatile constituents are allowed to come to equilibrium with the jar headspace. The headspace is then measured with a calibrated PID or FID, with a result expressed in parts per million (ppm). Due to the different ionization potentials of various compounds, actual levels of contamination cannot be determined. However, this technique provides an effective means of screening.

The following equipment is required for conducting the JHT:

- Soil sampling equipment (shovel, bucket auger, soil borer etc.);
- Wide mouthed, metal screw top 16 oz jars, with cardboard lid liner removed, and ¼ inch hole drilled through center, and roll of heavy duty aluminum foil; **or**
- One quart, zip lock type polyethylene bags;
- PID or FID

### PROCEDURE

1. Warm up and calibrate the PID and FID instrument to be used according to the manufacturers recommended procedure (See additional considerations with use of PID/FID below). The PID and/or FID should be ready for use prior to collection of the first sample.
2. Collect the soil sample with appropriate soil sampling equipment. See Soil Sampling Procedure and the “Final Policy Preservation of VOCs in Soil Samples” SOP dated March 2000.
3. Place approximately 250 grams of the soil sample into a wide mouth jar or polyethylene bag. One or the other should be consistently used at the site for comparison purposes, do not mix headspace containers. In so far as possible, samples should be mineral soil free of vegetation and stones larger than ½ inches in diameter. If soil samples are of different type (loam, sand, silt), this should be identified in the field log book. If a duplicate sample is to be submitted to the laboratory for analysis, this sample should be containerized and preserved as appropriate **now**. Soil that has been screened with JHT should not be submitted for laboratory analysis, unless so documented. If using jars, the jars should be sealed now by placing a square of foil over the mouth and screwing on the lid. If using a bag, the bag should be zipped closed leaving sufficient air in the bag so that the instrument can withdraw an adequate headspace sample.

4. Shake the jars for 30 seconds to thoroughly mix the contents. If bags are used, they may be kneaded until the contents are uniform.
5. Allow at least fifteen minutes but not more than two hours for VOCs to reach headspace equilibrium with the headspace. An attempt should be made to allow the same amount of equilibration time for each sample.
6. Shake jars/knead bags again for thirty seconds.
7. Measure the samples headspace concentration with the instrument. If the jar is used, break the foil seal through the drilled hole in the jar lid, and insert the probe approximately ½ inch into jar. If using the poly bag, open the seal just enough to insert the probe (this is easiest using two people). Record the highest reading on the instrument after allowing the probe to “sniff” the container for 10 – 15 seconds. It is important to obtain insert the probe as quickly as possible after the seal to the container has been broken. Once a jar has been used, it may not be used again for JHT screening.

#### **ADDITIONAL CONSIDERATIONS WITH USE OF A PID/FID**

There are limitations of PIDs and FIDs. A PID and FID cannot detect all VOCs, nor do they detect all VOCs equally. Factors that influence the response of the particular compound include ionization potential of compound, particular energy rating of lamp, calibration standard used, response factor, response curve, etc. In some instances, such as when the contaminant of concern is a single known compound, it is possible to calibrate the instrument so that a relatively accurate measurement, when compared to laboratory analysis, can be obtained. Because of this, it is recommended that the operator who will be conducting JHT take the time before the sampling event to become familiar with the particular instrument that will be used. This includes reviewing the specific user manual, calibration and practice with the instrument prior to the sampling event.

#### **DOCUMENTATION**

It is important that documentation include the specific lamp energy rating, calibration standard, and special response factors or curves that may be employed for the particular sampling event. When documenting such a sampling event, one should include enough information so that in the future another person can easily conduct the same sampling in a manner consistent with the previous event.

## SEDIMENT SAMPLING PROCEDURE

This procedure applies to the collection of sediment samples from rivers, lakes, streams, and other water bodies, for contaminant analysis. Sediments are typically defined as fine-grained, natural materials; transported and deposited by water; and are not unduly affected by processes that are localized. In general this procedure requires a minimum of two sample personnel for safety concerns.

The methods described here are for collection of surface sediments, generally to a depth of about 6 to 8 inches, and for collecting sediment cores, which can extend several feet into sediment (subsurface sediment). All sampling equipment shall be decontaminated prior to use and between samples.

Weather conditions and data quality objectives should be considered and documented in the Sampling and Analysis Plan (SAP) when planning a surface water sampling event. Determine what conditions the sampling event should occur in: “dry” or “wet” and define those terms prior to your sampling event.

When collecting surface water, pore water, and sediment samples in the same location, sampling should occur in that order, surface water samples first, then pore water samples and finally sediment samples.

Sediment samples collected from the same water body should be collected from downstream to upstream locations. Shallow sediment sample locations shall be approached from downstream to minimize bottom disturbance to upstream locations. If the bottom sediment is disturbed, the sample will be collected from progressively upstream locations as required. Samples collected from a boat shall be collected from the bow or upstream side of the boat, away from the motor, with extreme care taken to avoid contamination of the sample.

**NOTE: The collection of samples for VOC analysis shall follow the guidelines written for soils in the New Hampshire Department of Environmental Services “Final Policy Preservation of VOCs in Soil Samples” dated March 2000.**

## EQUIPMENT

The following equipment is typically used in collecting sediment samples:

- Appropriate health and safety gear and an approved site-specific Health & Safety Plan;
- Waders;
- Sample containers, preserved as necessary, cooler and ice;
- Plastic bags to protect and store samples;

- Site Specific SAP which includes well logs, map and other project-specific information;
- Field data from last sampling event if available;
- Field data sheets, sample labels, chain of custody forms;
- Logbook, pencil/pen/sharpies, calculator;
- The manufactures instruction manuals for all equipment, if applicable;
- Decontamination supplies/equipment;
- Distilled (deionized water);
- Paper towels;
- Stream staff/gage or similar measuring device;
- Toolbox to include general items such as large and small wrenches, pliers, screw drivers, 25' measuring tape, hose connectors, sharp knife (locking blade), duct tape, at a minimum;
- Camera to take digital pictures;
- Stainless steel scoops, bowls, spoons;
- Hand augers;
- Coring tubes; and
- Eckman or Ponar dredges.

## **SURFACE SEDIMENT SAMPLE COLLECTION**

Surface sediment samples, in shallow water, may be collected with stainless steel scoops, bowls, spoons, hand augers, or coring tubes that are hand held or attached to a coring tool. In deeper waters dredge samplers, such as Eckman or Ponar dredges, should be used unless otherwise specified. The following procedures are applicable for surface sediment sample collection.

1. Using a stream staff/gage or similar measuring device, measure the depth of water from the bottom of the streambed to the surface of the water and record the measurement.
2. Using a stainless steel scoop, dredge, or other sampling device, slowly scoop or otherwise collect and retrieve the surface sediment from the bottom of the upstream location, and place the sample into a stainless steel bowl or pan. Collection of plant or foreign material that is not part of the sample should be avoided.
3. If more sediment is needed, collect additional sediment next to the original sampling location to ensure staying within the required depth. Continue this procedure until the appropriate volume of sediment is obtained, and carefully decant excess liquid from the bowl.

4. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate.
5. Thoroughly mix sediment to obtain a homogeneous sample by quartering the sample, mixing each quarter and mixing all quarters together as described under sample mixing at the end of this document.
6. Remove any leaves, twigs, rocks or other gross debris that may have been collected.
7. Fill and cap the sampling containers and clean the exteriors of the containers to remove any potential residue.

### **SUBSURFACE SEDIMENT SAMPLE COLLECTION**

Subsurface sediment samples greater than 8 inches in depth may be collected using coring devices that are pushed, driven, dropped, or vibrated into the sediment, and retrieved. The coring devices include split spoon type samplers, and tubes made of metal or plastic material, from which samples are extruded (with or without the aid of a tube liner). During retrieval, the core is typically retained in the tube by one or more of the following: capping the top of the tube to provide a vacuum, use of a core catcher, or by driving the tube into a clay layer to form a plug. The following procedures are applicable to subsurface sediment sample collection.

1. Advance the coring device into the sediment. A gentle rotation of the coring tube may aid penetration.
2. Cap the top of the tube (if applicable) to provide a vacuum for sample retention during retrieval.
3. Pull the sampler from the sediment and decant excess liquid from the surface of the sample. If the sample is to be stored or transported for processing, cap both ends of the core barrel (or the insert after removal) and store upright (the top of the barrel or insert shall be marked or identified).
4. Open (for split spoon sampler), extrude and/or remove the sample from the sampler on a clean sampling pan or equivalent. Cut or divide the sample into the desired sample intervals.
5. Place sample in an appropriate size stainless steel bowl or pan. If more sediment is needed, collect additional sediment next to the original sampling location to ensure staying within the required depth. Continue this procedure until the appropriate volume of sediment is obtained. When collecting duplicates, collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate.

6. Thoroughly mix sediment to obtain a homogeneous sample by quartering the sample, mixing each quarter and mixing all quarters together as described under sample mixing at the end of this document.
7. Fill and cap the sampling containers and clean the exteriors of the containers to remove any potential residue.

## **DIVER COLLECTED SAMPLES**

In some instances diver collected samples are desired for visual and/or video inspection and documentation of the sample area. Sampling equipment should be lowered and retrieved in a plastic crate or equivalent connected to a rope or winch system. Divers should descend with the aid of a weighted line, which will remain available for the duration of the dive to aid descent and ascent.

- Bulk sediment samples that are not collected for trace contaminant analysis may be collected by divers in plastic 5 gallon buckets and sent to the surface via a rope or winch.
- Surface sediment samples collected for trace contaminant analysis should be collected in a stainless steel device or sample jars and sent to the surface for mixing and containerization. Mix the sediment by quartering the sample, mixing each quarter and mixing all quarters together as described under sample mixing at the end of this document. Fill and cap the sampling containers and clean the exteriors of the containers to remove any potential residue.
- Subsurface sediment samples may be collected by pushing a hand held core sampler into the sediment following step 1 and 2 of the subsurface sediment sample collection section above. The core barrel or insert shall be capped on both ends, stored upright, and sent to the surface for processing.

## **SAMPLE MIXING**

With the exception of VOC samples, it is important that the sediment samples be mixed as thoroughly as possible to ensure that the sample is representative of the sample interval. A common method of mixing is referred to as quartering. The soil in the sample pan is divided into quarters. Each quarter is mixed, and then all quarters are mixed into the center of the pan. This procedure is followed several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion and occasionally turning the material.

**Note:** If samples are predominantly moist and clayey, extra effort may be necessary to produce a homogeneous mixture.

## **QUALITY ASSURANCE SAMPLES**

Collect appropriate quality assurance samples as specified in the SAP.



Collect at least one duplicate sediment sample by: collect enough sample material in the stainless steel mixing bowl for both the sample and the duplicate, thoroughly mix the sediment to obtain a homogeneous sample; remove any leaves, twigs, rocks or other gross debris that may have been collected; fill and cap the containers for both the sample and duplicate sample.

Equipment Blanks should be collected to ensure that the equipment is clean and the decontamination procedure is adequate.

## **DECONTAMINATION**

Decontaminate equipment following approved decontamination procedures. Disposable sampling equipment shall be discarded after completing the sampling task and not reused.

## **EQUIPMENT BLANK**

Collect appropriate equipment blanks on the equipment used, for all the parameters associated with the equipment to ensure that the decontamination procedure is adequate.

## **DOCUMENTATION**

In general all data and sampling information will be documented as recorded as specified in the SAP. Specific reporting of these sampling events may include, but is not limited to, the following information:

1. Past 7 days of local meteorological data showing a minimum of daily precipitation totals and barometric pressure;
2. Water depths at various points along the streambed;
3. General physical description of the samples and sampling locations; and
4. Digital photographs of sampling locations including one or more of the larger surrounding area.

## **RESIDENTIAL WATER SAMPLING PROCEDURE**

The purpose of this document is to describe the procedure for collecting water samples from household wells (dug, drilled, etc.), either with or without water treatment devices, at or near contaminated sites.

Sampling household water supplies is essential to the proper investigation of groundwater contamination at a potential/ actual contaminated site for the protection of human health. Each well supplying a household(s) also represents a monitoring well for local groundwater. Such information/data should be factored into the groundwater investigation program.

The project manager will prepare a list of the wells and the analytical parameters to be sampled. A map will be provided, if necessary. Notification to homeowners will be made by the project manager or the sampler. To the extent possible, attempt to avoid contact with water that is suspected or known to be contaminated by the use of appropriate personal protection equipment. Document any observations and/or comments about matters pertinent to the sample and/or site.

Sampling personnel must use common sense prior to and during sampling activities in order to avoid problems. For instance, samplers should try to avoid gassing up a vehicle on the day of the sampling event. Sampling personnel should also remember that they are at someone's home and so should not do anything to adversely impact the residence or unnecessarily inconvenience the resident.

### **DEFINITIONS**

Point of Entry (POE) Treatment System - A device which removes contaminants from water by volatilizing the contaminants out of the water (such as an air stripper), or a device packed with granular activated carbon which removes contaminants by adhesion from the water as the water passes through it.

Other types of water treatments systems may consist of: radon, sediment or iron filters; water softeners; pH adjusters; etc.

Sample Point - Any location from which a representative water sample may be obtained.

### **SAMPLING HOUSEHOLDS WITHOUT A POE SYSTEM**

When sampling at a household with no POE system, take the sample from an indoor faucet (kitchen, bathroom, other) or an outside spigot, preferably from the closest spigot to the well in the plumbing system. An outside spigot is preferable to an inside faucet to prevent unnecessary overloading of the septic system. Make sure that the sample point is clean (i.e., no grease, lead soldering, or other possible contaminants) and that no possible sources of cross-contamination (gas cans, solvents, etc.) are nearby. If there are other water treatment systems in place, the sample should be collected prior to these systems or bypassed, if possible. If sampling from a kitchen faucet, remove the aerator if conditions allow; if sampling from an outside spigot,

remove any hoses or attachments to the spigot before the sample is collected. Run the water on cold at a high rate of flow for a minimum of 10 minutes.

Running the water will accomplish two goals. First, it will purge the pipes of any stagnant water; second, it will drain the pressure tank and cause the pump to turn on and start pumping the well. This should assure the collection of a fresh and representative sample from the well.

After the water has run for a minimum of ten minutes, reduce the flow to a very slow rate (this prevents excessive spray and also reduces volatilization); and obtain a sample using the appropriate containers.

After you have taken all the required samples, turn off the water and replace any removed parts (aerator, hose, etc.). Wipe and dry the sample containers.

### **SAMPLING HOUSEHOLDS WITH A POE TREATMENT SYSTEM**

For households with a POE system, sample in order from the least contaminated sample point to the most contaminated sample point to insure the smallest chance for cross-contamination. Therefore, the sample order should be the fully treated, partially treated and untreated sampling points. Also be aware that some systems have additional filters/strippers/softeners before the treatment unit, and the sample must be obtained prior to these. Make note of such additions to the system in your field notebook. Gloves must be worn and changed between sample ports, not only to prevent cross-contamination of samples, but also to protect the sampler from dermal exposure.

Begin the process by turning the cold water on at one of the household taps at a high rate of volume, and running the water for a minimum of 10 minutes. This will purge not only the pipes, but also the GAC filters. If sampling from a sink faucet, be sure to remove any aerators on faucet if possible.

In all cases, once the line has been purged, decrease the water flow to a very slow rate (this prevents excessive spray and also reduces volatilization), and obtain a fully treated sample using the appropriate containers.

The partially treated sample should be taken next. Run this sample port water ten to twenty seconds prior to sampling to remove any residue/contaminants from the port. Use a bucket to catch the excess water produced when running the water and taking the sample.

The untreated sample before the POE system is taken last due to its highest probability of being contaminated. Run the sample port water ten to twenty seconds to remove the residue/contaminants from the port. The bucket will again be necessary to catch excess water from this sampling port.

If multiple treatment components exist, it may be necessary to take more samples. Many air-strippers have ports (spigots) both before and after the stripper expressly for the purpose of taking samples. Filtration devices can often be bypassed with bypass valves included in the

plumbing. When sampling any of these devices, trace the route of the plumbing (pipes) to make sure the sample is being taken from the correct sampling port. Once all the samples have been collected from a residence, return all plumbing to its original position (aerator back on faucet, all sample ports closed).

#### **QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)**

For VOC analysis, a trip blank should be collected from the laboratory doing the analysis, preserved with the same preservative as the actual samples, stored and transported with the other samples collected during the sampling event, and then analyzed (along with the other samples) for the appropriate suspected contaminants by the lab.

Duplicate samples shall be collected in the field at a minimum frequency of one per 20 sample locations. The duplicate sample shall be obtained at the same time and location and using the same method as used for the primary sample collection.

## **DECONTAMINATION PROCEDURE**

### **PURPOSE**

The purpose of this Standard Operating Procedure (SOP) is to provide a procedure for preventing, minimizing, or limiting cross-contamination of environmental samples. This procedure is intended to ensure that field equipment is properly and adequately decontaminated in order to preserve the integrity of data collected with that equipment in the field, as well as to protect staff working with the equipment from exposure to contaminants.

This SOP focuses on small equipment decontamination (e.g., pumps, water level meters, hand augers, stainless steel spoons and mixing bowls for sediments, etc.).

For site work involving large equipment, such as backhoes, bulldozers, drill rigs, etc., a specific decontamination procedure will be required in the site-specific Sampling and Analysis Plan (SAP). As a guideline, a thorough brushing, scraping, washing and/or steam cleaning should be completed. Such maximum contact points as tires, treads, buckets, blades, and drill pipe/bits, should be thoroughly decontaminated in an effort to prevent migration of contaminants off the site. At sites where equipment becomes highly contaminated, provisions to collect rinsate water/solutions may have to be made.

Decontamination is an essential part of a successful field operation as it: prolongs the usable life of the equipment; lessens the potential for cross-contamination of samples; prevents the mixing of incompatible substances; and reduces the likelihood of contamination leaving the site and threatening other areas with contamination.

In addition to this guideline, personnel should also review the manufacturer's user manual for any equipment specific recommended decontamination procedures.

### **EQUIPMENT AND MATERIALS**

The following is a list of equipment and material commonly used for decontamination:

- Non-phosphate detergent (alconox);
- Selected solvent rinses (i.e. pesticide-grade isopropanol, hexane, etc.) with spray bottles;
- Tap water;
- Distilled or deionized water;
- Long and short handled brushes and bottle brushes;
- Drop cloth/plastic sheeting;
- Paper towels;
- Plastic or galvanized tubs or buckets;

- Pressurized sprayers;
- Aluminum foil;
- Ziploc® plastic bags; and
- Appropriate personal protective equipment (i.e., safety glasses appropriate gloves, boots).

## **GUIDELINES**

All decontamination procedures should be completed with an appropriate level of personnel protection no more than one level below the level the fieldwork was completed in; no less than level D which includes safety glasses, chemically resistant gloves, boots, overalls, etc.

Each item used for the decontamination of equipment may also become contaminated and must be appropriately handled, stored, and either decontaminated itself or disposed of. Certain items that become grossly contaminated and cannot be practically decontaminated (i.e. small tools and tools with wooden handles) should be disposed of properly. In some instances it is more practical and sensible to dispose of these items properly than to attempt decontamination. Such decisions will be made by the project manager and specified in the site-specific SAP.

In addition, decontamination of equipment generates Investigative Derived Waste (contaminated rinse liquids, sludges, etc.) that may need to be containerized onsite until proper disposal arrangements are made. The Project Manager will use professional judgment and guidance documents such as Guide to Management of Investigation-Derived Wastes, EPA 93-45303fs-s, January 1992, located at <http://www.epa.gov/superfund/policy/remedy/pdfs/93-45303fs-s.pdf>, on a site by site basis to determine if the levels of contamination are sufficiently low so that disposal at a hazardous waste facility is not necessary. This information shall be specified in the site-specific SAP.

## **GENERAL PROCEDURE FOR SMALL EQUIPMENT DECONTAMINATION**

This procedure refers to both the inside and outside of equipment where appropriate. The decontamination procedure is summarized as follows:

1. Disassemble equipment, as required;
2. Remove gross contamination from the equipment by brushing and then rinsing with tap water;
3. Wash the equipment with a non-phosphate detergent and tap water;
4. Rinse with tap water;
5. Rinse with the appropriate solvents\*, as required;
6. An additional step of wiping the equipment with appropriate solvent (i.e. hexane) saturated paper towels may be necessary if the equipment made contact with LNAPL to assist in it's removal;

7. Rinse the equipment with distilled/deionized water between solvent rinses with a final rinse of distilled/deionized water;
8. Air dry equipment; and
9. Secure clean equipment.

**\* Solvents**

In some instances, an additional wash with a solvent, such as isopropyl alcohol or hexane may be required depending upon the contaminant. The need for a solvent wash will be determined on a site by site basis by project manager prior to the sampling event and be stated in the site-specific SAPs. A solvent wash may be necessary in the case of sampling in high levels of contamination, or when sampling particularly difficult to clean contamination such as LNAPL or coal tar. Lab personnel can assist in determining an appropriate solvent.

**SPECIAL NOTES**

**The decontamination procedure for water level meters and oil/interface probes shall include the probes and, at a minimum, the length of tape used in that well.**

With instruments such as multiparameter meters and turbidity meters, the probes, flow through cells and turbidity vials shall be thoroughly rinsed with distilled water. If appropriate, some of these items may be washed with non-phosphate detergent and tap water, rinsed with tap water and finally rinsed with distilled water. Sensitive equipment that is not water proof should be wiped down with a damp cloth. Great care shall be taken not to damage the instrument.

If the equipment to be decontaminated is delicate, such as a PID or a CGI, the best way to avoid the need to decontaminate them is to prevent contact with contamination in the first place. Develop a method of wrapping/bagging these instruments in polyethylene sheeting/bags so that contact with contamination is minimized but the performance of the instrument is not adversely effected (i.e. the knobs made inaccessible, the meter covered, etc.).

All field activities must be carried out in accordance with a site-specific Health and Safety Plan. MSDS' are required to be on site when using decontamination acid and/or solvent solutions.

**IDW (Investigative Derived Waste) Disposal, if Appropriate**

**Solid Waste** – Place all solid waste materials generated from the decontamination area (i.e., gloves and plastic sheeting, etc.) in an approved container.

**Liquid Waste** – Place used soap water and solvent liquid wastes into 5-gallon plastic containers and store with lid on. Contact the appropriate personnel to arrange for disposal.

## **ALTERNATIVES**

Decontamination is, by its nature, an arduous and painstaking task which is often better to avoid. Avoid decontamination procedures whenever feasible by implementing alternative plans of action such as:

- Dedicating specific equipment to a specific site(i.e. specific bailers to specific wells) when economically feasible;
- Using disposable equipment when applicable and;
- Wrapping monitoring equipment in plastic bags (or other materials) to protect from contamination. It is important to keep monitoring equipment such as photoionization detectors (PID) or combustible gas indicator (CGI) from contacting soil or liquids at hazardous substance sites. If an instrument (PID or CGI) becomes contaminated it must be decontaminated. By eliminating contact with contamination and/or using disposable equipment, decontamination of equipment may be avoided.

## **QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)**

To insure that decontamination procedures are meeting the expectations/requirements (i.e., removing detectable levels of contamination) equipment blanks must be taken and analyzed as stated in the site specific SAP.

Items such as pH meters, specific conductivity meters, PIDs and CGIs must be calibrated after decontamination to insure proper future measurements/readings.

## **TROUBLE SHOOTING**

If an equipment blank is analyzed and found to contain a contaminant, possible sources of error will have to be investigated to determine whether or not the decontamination procedures were properly followed. Possible sources of error include: inadequate scrubbing/ washing/ rinsing of equipment; use of incorrect decontamination solvent/solutions, use of contaminated detergents or rinse waters; contact with contaminants after decontamination but prior to sampling, and/or, lab error.

## **REFERENCES**

US DHHS, 1985. Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities. U.S. Department of Health and Human Services, Washington, D.C..

US EPA, 1984. Standard Operating Safety Guides. Office of Emergency and Remedial Response, Washington, D.C..



## **PORE WATER SAMPLING (GROUNDWATER/SURFACE WATER INTERFACE SAMPLING)**

### **PURPOSE**

The purpose of this document is to describe the standard operating procedure (SOP) for collecting groundwater samples using a pore water sampler. All personnel who collect these types of samples must be appropriately trained in this methodology.

It is often difficult to determine the extent and origin of contamination using solely surface water sampling techniques. In some cases, a surface water body may be clean but the groundwater beneath it may be contaminated. Thus, sampling the groundwater prior to its discharge to a surface water body may lead to a better understanding of the extent and origin of contamination. This can be accomplished by using a pore water sampler. Underlying the procedure is the assumption that surface water bodies are common discharge points for groundwater. Thus, a sample of the water beneath a stream or riverbed would be characteristic of the groundwater in the area.

### **HEALTH AND SAFETY**

All personnel must understand that if a sample cannot be obtained safely, the sample should not be taken at all. If a sample cannot be obtained due to safety considerations it should be documented in the sampler's field book.

All personnel should be aware of the potential dangers associated with this particular sampling method. These dangers include, but are not limited to, strong water currents, slippery substrate, roots or sharp objects beneath the water's surface that may cause a fall or other personal injury. All necessary precautionary measures should be heeded when performing this sampling technique.

### **EQUIPMENT**

The following is a list of equipment for collecting groundwater samples using the pore water sampler method.

- Appropriate health and safety gear and an approved site-specific Health & Safety Plan;
- Waders;
- Pore Water Samplers;
- Peristaltic pump with a sampling head capable of pumping low speeds (40-50 milliliters per minute);
- Polyethylene Tubing with an inside diameter (ID) of one-quarter (1/4) inch to fit around the top opening of the pore water sampler. Enough tubing to reach from the pore water sampler to the shore;

- Pharmaceutical/Medical Grade Silicone Pump Tubing three-eighths (3/8) inch inside diameter (ID) will be necessary to connect the pore water sampler to the peristaltic pump;
- Power Supply (battery) will be necessary to operate the peristaltic pump;
- A multiparameter meter for measuring Temperature (°C ) and Dissolved Oxygen (DO) in mg/L with a 250 ml maximum volume flow through cell; the same make and model as used for the site groundwater sampling. The probes must be waterproof to collect in-situ parameter readings of the surface water;
- A probe guard for the multiparameter meter to collect in-situ parameter readings of the surface water;
- Small wet sponge or paper towel for DO 100% saturation calibration
- Zero Dissolved Oxygen solution to check the DO calibration;
- A turbidity meter and standards: the same make and model and standards as used for the site groundwater sampling;
- A three way stopcock to divert sample flow for turbidity reading:  
(i.e. Nalgene three-way stopcock with a plug bore of 4 mm (or 0.157 in) NNI No. 6470-0004 VWR catalog No. 59097-080);
- A clear 250 ml graduated cylinder;
- Plastic sheeting/bucket or table to set peristaltic pump on;
- Clear plastic bags to separately store the tubing from each sampling location;
- Sample containers, preserved as necessary, cooler and ice;
- Plastic bags to protect and store samples;
- Site Specific Sampling and Analysis Plan (SAP) which includes well logs, map and other project-specific information;
- Field data from last sampling event if available;
- Field data sheets, sample labels, chain of custody forms;
- Logbook, pencil/pen/sharpeners, calculator;
- The manufactures instruction manuals for all equipment;
- Decontamination supplies/equipment;
- Distilled (deionized water);
- Paper towels;
- Stream staff/gage or similar measuring device;
- Toolbox to include general items such as large and small wrenches, pliers, screw drivers, 25' measuring tape, hose connectors, sharp knife (locking blade), duct tape, at a minimum; and a

- Camera to take digital pictures.

A pore water sampler comes in two parts, a strengthening rod and the pore water sampler itself, both made of stainless steel. The pore water sampler is basically a hollow tube with small holes in its tip that allow groundwater to percolate through. The strengthening rod slides into the pore water sampler, and while in place, blocks all water from entering pore water sampler. Both pieces are placed in a PVC sheath for protection.

**Although the pore water sampler is fairly sturdy, exercise caution during use, as once either piece becomes bent, the equipment is useless.**

Bring at least as many pore water samplers as there are sampling locations, as onsite decontamination is difficult and should be avoided.

## **PREPARATION**

Prior to undertaking any groundwater sampling using the pore water sampler, a site and event specific Sampling and Analysis Plan (SAP) and/or a Quality Assurance Project Plan (QAPP) should be developed. A SAP should specify the sample points and the means of accessing the sample points.

Weather conditions and data quality objectives should be considered and documented in the SAP when planning a pore water sampling event. Determine what conditions the sampling event should occur in: “dry” or “wet” and define those terms prior to your sampling event.

If sampling for other media at the same location, the samples should be collected in this order:

1. Surface Water Samples
2. Pore Water Samples
3. Sediment Samples

Low flow purging and sampling protocol is not required, but if desired, refer to the Low Flow Groundwater Purging and Sampling SOP in the QAPP.

If sampling for metals, it is recommended that turbidity be measured. If turbidity is above 30 NTUs, it is recommended that an additional sample be collected that has been filtered through a 0.2-0.45 micron inline particulate filter.

Pore water sampler should be inserted deep enough as to ensure the sample collected will contain only groundwater and no surface water. Typically, this depth is at least 8 inches. In order to help ensure that you are actually into the pore water, DO and temperature readings will be collected from both the surface water and the pore water at each sampling location. DO and temperature readings will be collected from the surface water in-situ prior to pore water sampling. Dissolved Oxygen (DO) and temperature readings will then be collected from the pore water for comparison. Pore water DO is expected to be less than two (2) mg/l; whereas most surface water DO is expected to be above eight (8) mg/l. Pore water also tends to be colder than surface water. These values are to be used as guidance as the actual results may vary.

Course sediment and sediments with a high percentage of organic matter are the most transmissive; with experience, samplers can actually “feel” the type of sediment as the pore water sampler is advanced. If the formation intercepted by the screen is not transmissive enough for collection of sample, gently advance and/or pull back the sampler in an attempt to find a more transmissive zone. If formation does not allow adequate transmission of water, it may require a change in sampling location. This change is made at the discretion of the sampler, unless otherwise specified in the SAP, and should be documented in field notes.

All field equipment shall be calibrated according to the Calibration of Field Instruments SOP in the QAPP;

### **SAMPLING PROCEDURE**

1. Calibrate the DO to 100% saturation and check the calibration with a Zero DO solution;
2. Calibrate the turbidity meter and check the calibration with the 20 NTU standard;
3. Select the appropriate sampling location within a one foot radius of the sample location stake;
4. Using a stream staff/gage or similar measuring device, measure the depth of water from the bottom of the streambed to the surface of the water and record the measurement.
5. Attach the probe guard to the multiparameter meter;
6. Insert the meter into the stream at mid-depth to collect in-situ readings;
7. Let readings stabilize and record DO and temperature results on the attached sampling worksheet;
8. Carefully insert a pore water sampler into streambed to the desired depth (refusal, with a minimum number of inches as specified in the SAP) using a twisting motion.

**Do not remove strengthening rod until instrument has been securely placed in sediment.**

Once this has been accomplished, remove the strengthening rod from the pore water sampler;

9. Record the approximate depth of the screen;
10. Connect pore water sampler to peristaltic pump using appropriate tubing;
11. Connect the tubing to the three way stopcock and then the multi-meter;
12. Turn pump on and start to purge at a rate of 40-50 ml/minute. Pumping rate should be low enough to ensure that surface water is not being drawn in;
13. Collect and record DO, temperature and turbidity readings every 1-2 minutes (or as specified in the SAP) until purge water is free of particulate. If sample is not visually free of sediment, it should be documented in field notes;

14. After water has been sufficiently purged, decrease pumping rate and begin collecting the samples. Pumping rate should be low enough to ensure that surface water is not drawn down into the sample;
15. Wipe off the exterior of the containers with clean paper towels;
16. Label and store the sample in accordance with appropriate protocol;
17. Once sample has been taken, turn off pump, disconnect all tubing and remove the multiparameter meter and pore water sampler from river/streambed;
18. The pore water sampler shall be decontaminated before further use at subsequent sampling locations. The tubing shall be properly discarded.

**Do not put strengthening rod back in pore water sampler once sample has been collected, as sediment in the sampler must be flushed out first.**

**Rather, place both pieces separately into a plastic sheath (bag) for decontamination.**

19. Repeat the above process at all sampling locations;
20. Collect a minimum of one duplicate sample.

## **DECONTAMINATION PROCEDURE**

Decontaminate the pore water samples according to the approved decontamination procedures with the addition of the following step:

In the course of sampling, sediment will build up in sampler that must be carefully flushed out. For this reason, it is best if decontamination is conducted with a large amount of water available for continuous flushing. If possible, bring as many pore water samplers as there are sampling locations, as onsite decontamination can be difficult.

## **QUALITY ASSURANCE SAMPLES**

The SAP or QAPP should outline the data quality needs for the event.

- Include a trip blank if collecting VOCs;
- Duplicate samples shall be collected for each batch of 20 samples collected per matrix, per analysis; and
- Collect an equipment blank after decontamination to insure that decontamination procedures are adequate.

## **DOCUMENTATION**

In general all data and sampling information will be recorded as specified in the SAP. Specific reporting of these sampling events will include, but is not limited to, the following information:

1. Past 7 days of local meteorological data showing a minimum of daily precipitation totals and barometric pressure;
2. Depth of water at the sampling location;
3. Any water quality parameter readings taken;
4. General physical description of the samples and sampling locations
5. Observational data concerning the groundwater, such as the approximate depth of the screen when the sample was collected, any detection of odor or contamination, color and turbidity.
6. Digital photographs of sampling locations including one or more of the larger sampling area.

## **REFERENCES**

Protocol for Groundwater/Surface Water Interface Sampling using a Pore Water Sampler, DR#023, Revision: 2, 2004, Maine Department of Environmental Protection, Division of Site Remediation

## Pore Water Samnpling Worksheet

Page \_\_\_\_ of \_\_\_\_

Date : \_\_\_\_\_

Well ID : \_\_\_\_\_

## Field Personnel

Purging Start Time : \_\_\_\_\_

Pore Water Depth in feet: \_\_\_\_\_

Time at Sample Completion: \_\_\_\_\_

Samples collected: \_\_\_\_\_

Signature: \_\_\_\_\_

CURRENT WEATHER		WEATHER PAST 7 DAYS							
Barometric Pressure (mm/hg)		Dates:							
Storm (heavy rain)		Barometric Pressure (in mm/hg)							
Rain (Steady Rain)		Estimated Rainfall (in)							
Showers (Intermittent)		Notes:							
Cloud Cover (%)									
Clear/Sunny									
Comments:									

[illegible]

Notes: NR = No Reading

**Tubing Factors:** Milliliters to purge standing water in tubing

1/2" ID: height in ft.x 38.59 = ml needed

1/4" ID: height in ft.x 9.64 = ml needed

1/8" ID: height in ft. x 2.41 = ml needed

## **CALIBRATION OF FIELD INSTRUMENTS**

### **PURPOSE**

The purpose of this standard operating procedure (SOP) is to provide a framework for calibrating field instruments used to measure water quality parameters for ground water, surface water and pore water. Water quality parameters include temperature, pH, dissolved oxygen (DO), specific conductance, Oxidation Reduction Potential (ORP) and turbidity.

Although this SOP is primarily written for automatically temperature corrected multiparameter instruments with probes for temperature, DO, pH, specific conductance, and ORP, such as the YSI Models 600XL or 6820 or the QED Model MP20; this SOP also applies to separate instruments for the parameters listed. Turbidity must be taken with a separate meter (such as the Hach 2100P Turbidity meter). pH meters must be calibrated using three pH standards (4, 7 and 10 pH units).

**All field instruments must be calibrated once in the office prior to the sampling event to ensure that the units are working properly.**

When the low flow purging and sampling procedure is used, the instrument(s) shall be equipped with a flow-through-cell with a maximum capacity of 250 milliliters. Turbidity must be taken at a point before the flow-through cell and from a meter separate from the flow through cell apparatus.

### **CALIBRATION ACCEPTANCE CRITERIA**

The instruments shall be calibrated at the beginning of each sampling day at the Site prior to sample collection. The calibration shall then be checked immediately following the calibration to ensure the instrument was calibrated properly. If the morning calibration check is not within the acceptable range for that parameter, the instrument shall be recalibrated using all the standards for that parameter and the calibration shall be checked again. See individual parameters for specific instructions. If problems with the instrument continue, backup instruments shall be calibrated and used in place of the inoperable unit.

The calibration shall be checked again at the end of the day of use to ensure that the instruments have remained in calibration throughout the day. In addition, should any erratic or illogical readings occur between calibrations, the instrument shall be recalibrated in order to ensure that representative measurements are obtained. All calibration and check values shall be documented on the calibration log maintained by each user (see attached log).

If a calibration check at the end of the day is not within the acceptable range for that parameter, the data collected that day for that parameter shall be qualified in its use. This qualification shall be documented on the field sheets/logs for the appropriate sampling locations. For example: pH



measurements are collected as part of the low flow sampling procedure. If the afternoon pH calibration check was not within the acceptable range that day, the pH data collected by that instrument on that day would be qualified as useful only for determining stabilization and not as representative pH measurements of the water being sampled. That qualification would then be documented on the calibration log and the sampling sheet / log book for each of those locations.

## **EQUIPMENT AND MATERIALS**

The following is a list of equipment and materials commonly used during calibration:

- Multi-meter sonde and handheld meter (such as the YSI Models 600XL or 6820 or the QED model MP20)
- Calibration solutions:
  - “Zero” check 0 mg/L DO standard
  - pH buffers 4, 7 and 10
  - Two standards for specific conductance: one lower value (447 $\mu$ S/cm) for calibration, one higher value (718  $\mu$ S/cm or a 1,413  $\mu$ S/cm) for checking calibration; and
  - Zobell Solution for ORP
- Small wet sponge or paper towel for DO 100% saturation calibration
- Separate Turbidimeter (such as the Hach 2100P Turbidity meter) w/calibration standards (NTU <0.1, 20, 100, 800)
- Calibration cup with cap
- Cooler (for storage of calibration solutions)
- Distilled water
- Paper towels
- Kimwipes
- Barometer for instruments that require a separate barometer for the dissolved oxygen calibration
- NIST certified thermometer (degrees Celsius)
- Ring stand with clamp
- Calibration log

## **GENERAL INFORMATION**

In general, all instrumentation necessary for field monitoring and health and safety purposes shall be maintained, calibrated, tested and inspected according to the manufacturer's instructions. It is assumed that most of this equipment will be rented and is not owned by the contractor. Any

reference made to a vendor applies to the owner/renter of the equipment.

Prior to calibration, all instrument probes must be cleaned in accordance with the manufacturer's instructions, preferably via the vendor if the unit is rented. Failure to perform this proper maintenance step can lead to erratic measurements. The vendor is required to provide written documentation (which will be included in sampling reports) that indicates the equipment was cleaned, by who and dated.

Calibration standard values, check results, temperature and barometer checks, and maintenance for each piece of equipment shall be documented on the calibration logs and included in reports as requested by the NHDES project manager. This information includes dates, personnel, calibration standards expiration dates, etc. A calibration log is provided at the end of this SOP.

**This SOP requires that the manufacturer's instruction manuals (including the instrument specifications) accompany the instruments into the field.**

Turn on the instrument and allow it to warm up according to the manufactures instructions. Program the multi-probe instrument so that the following parameters to be measured will be displayed: temperature in °C; pH, dissolved oxygen (DO) in % for calibration and mg/l for measurements; specific conductance in µS/cm; and ORP in mV.

All calibration solutions shall be placed into the calibration cup to calibrate the instrument and to check the calibration. The probes shall not be put directly into the bottles of calibration solutions from the vendor. The volume of the calibration solutions must be sufficient to cover both the probe and temperature sensor. The zero DO standard check solution must be filled to the top of the container with no head space. See manufacturer's instructions for additional information.

While calibrating or measuring, make sure there are no air bubbles lodged between the probe and the probe guard.

Mark the "date opened" on each new bottle of calibration solution. Record the lot number and expiration date on the calibration log.

All calibration solutions shall be stored in the dark and stored at cool/stable temperatures. Storage of calibration solutions in an insulated cooler kept in the shade will help to maintain calibration solution integrity.

## **CALIBRATION PROCEDURES**

### **TEMPERATURE**

For instrument probes that rely on the temperature sensor, each temperature sensor must be checked for accuracy against a thermometer that is traceable to the National Institute of Standards and Technology (NIST) **at least once a year.**

**This procedure is not to be done in the field.**

The temperature check shall be performed prior to the field event, preferably via the vendor if the unit is rented. If the check is not performed by the vendor it will need to be performed by field personnel prior to using the unit. Verification and documentation of this procedure is required, including accuracy, dates and personnel; and included in any sampling reports.

### **Temperature Sensory Accuracy Procedure**

1. Allow a container filled with water to come to room temperature.
2. Place a thermometer that is traceable to the National Institute of Standards and Technology (NIST), and the instrument's temperature sensor into the water and wait for both temperature readings to stabilize.
3. Compare the two measurements. The instrument's temperature sensor must agree with the reference thermometer measurement within the accuracy of the sensor (usually  $\pm 0.15^{\circ}\text{C}$ ). Check the manual that came with the instrument. If the measurements do not agree, the instrument may not be working properly and the vendor/manufacturer needs to be consulted and the unit replaced.

## **DISSOLVED OXYGEN**

Dissolved oxygen (DO) content in water is measured using a membrane electrode.

**The DO probe's membrane and electrolyte solution shall be replaced on Site prior to the initial calibration and replaced as needed thereafter.** Failure to perform this step may lead to erratic measurements.

### **Barometer**

For instruments that require a separate barometer for the dissolved oxygen calibration, each barometer shall be checked against a The National Weather Service (NWS) Station calibrated barometer and adjusted accordingly at least once a year. If the barometer is rented, it shall be checked once prior to the sampling event by field personnel. **The barometer must be brought to a National Weather Service Station to be checked and adjusted.** Verification and documentation of this procedure is required on the calibration log; including accuracy (results before and after adjustments), dates and personnel. There is a NWS Station at the Concord Airport. Check with the NWS for other stations that may be closer.

### **DO Calibration Procedure**

1. Replace the DO probe's membrane and electrolyte solution prior to the initial calibration and replace as needed thereafter.

2. Inspect the DO membrane for air bubbles and nicks.
3. Gently dry the temperature sensor according to manufacturer's instructions.
4. Place a wet sponge or a wet paper towel on the bottom of the DO calibration container.
5. Place the DO probe into the container without the probe coming in contact with the wet sponge or paper towel.
6. Turn on the instrument to allow the DO probe to warm-up according the manufactures directions. Allow the confined air to become saturated with water vapor. Make sure that both the DO reading and the temperature have stabilized before starting the calibration sequence.
7. Select calibration mode; then select "DO %".
8. Enter the local barometric pressure (usually in mm of mercury) for the sampling location into the instrument using an on-site hand held barometer, unless the instrument already has a temperature-compensated barometer.
9. **Record the barometric pressure on the calibration log.**
10. The instrument should indicate that the calibration is in progress. Observe the readings for percent dissolved oxygen and temperature. When they show no significant change for approximately 30 seconds press enter. After calibration, the instrument should display dissolved oxygen in mg/L (% DO is only used for calibration).
11. **Record the initial DO reading in mg/L and temperature reading in °C on the calibration log.**
12. To check the calibration (in the run mode), remove the probe from the container and place it into a 0.0 (zero) mg/L DO standard. Do not put the DO probe back into the storage cup (w/sponge), prior to performing the zero check. The zero DO standard check solution must be filled to the top of the container with no head space. See manufacturer's instructions for additional information. Check temperature readings. They must stabilize before continuing.
13. Wait until the "mg/L DO" readings have stabilized. **Record the zero mg/L DO reading on the calibration log.** The instrument must read < 0.5 mg/L DO. If the instrument cannot reach this value, it will be necessary to clean the probe, and change the membrane and electrolyte solution. If this is unsuccessful, use a new 0.0 mg/L DO standard. If these measures are still unsuccessful, consult the manufacturer/vendor or replace the unit.
14. Remove probe from the zero DO standard, rinse with distilled water, and blot dry.

## pH (electrometric)

The pH of a sample is determined electrometrically using a glass electrode. Three standards are needed for the calibration: 4, 7 and 10.

### pH Calibration Procedure

1. Allow the buffered standards to equilibrate to the ambient temperature.
2. Fill calibration containers with the buffered standards so each standard will cover the pH probe and temperature sensor.
3. Remove probe from its storage container, rinse with distilled water, and blot dry with a Kimwipe. Use caution during drying that the dissolved oxygen probe membrane is not disturbed.
4. Select the calibration mode for a three point pH calibration.
5. Immerse probe into the initial standard, pH 7. Enter the buffered standard value (pH 7) into instrument. Wait until temperature and pH readings stabilize. If the readings do not change within 30 seconds, press enter to accept the calibration.
6. Remove probe from the initial standard, rinse with distilled water, and blot dry.
7. Immerse probe into the second standard (pH 4). Repeat step 5.
8. Remove probe from the second standard, rinse with distilled water, and blot dry.
9. Immerse probe in third buffered standard (pH-10) and repeat step 5.
10. Remove probe from the third standard, rinse with distilled water, and blot dry.
11. Select monitoring/run mode. To check the calibration (in run mode); immerse the probe into the pH 7 buffer solution. Wait for the temperature and pH readings to stabilize. **Record the pH value on the calibration log.** The value must be pH 7 +/-5% (pH 6.65-7.35). If the calibration check failed re-calibrate the instrument using fresh standards for all three values and check it again. If re-calibration fails, clean the pH probe, consult the manufacture/vendor or replace the unit.
12. Remove probe from the pH 7 check standard, rinse with distilled water, and blot dry.

## SPECIFIC CONDUCTANCE

Conductivity is used to measure the ability of an aqueous solution to carry an electrical current. Specific conductance is the conductivity value corrected to 25°C. When monitoring ground

water, surface water or pore water use the specific conductance readings and record in  $\mu\text{S}/\text{cm}$ .

Most instruments are calibrated against a single standard which is near, but below the specific conductance of the environmental samples. A second standard which is above the environmental samples specific conductance is used to check the linearity of the instrument in the range of measurements. Specific conductivity standards concentrations are generally dependent on expected field conditions and availability. However, the following problems have been reported in selecting the proper specific conductivity standards:

- Low specific conductance standards that are not stable in the field (i.e.  $84 \mu\text{S}/\text{cm}$ )
- Using standards with a range that is too wide between the calibration and check standards. (i.e.  $84 \mu\text{S}/\text{cm}$  and  $1000 \mu\text{S}/\text{cm}$ )

The following standards have been field tested, are readily available from most vendors, and are acceptable for use: a  $447 \mu\text{S}/\text{cm}$  standard to calibrate and either a  $718 \mu\text{S}/\text{cm}$  or a  $1,413 \mu\text{S}/\text{cm}$  standard to check the calibration. Those are the recommended standards to use.

### **Specific Conductance Calibration Procedure**

1. Allow the calibration standards to equilibrate to the ambient temperature.
2. Remove probe from its storage container, rinse the probe with a small amount of the lower value ( $447 \mu\text{S}/\text{cm}$ ) specific conductance standard (discard the rinsate), and place the probe into the standard. Gently move the sonde up and down to dislodge any air bubbles from the conductivity cell. The probe must be completely immersed past its vent hole.
3. Allow at least one minute for temperature equilibrium before proceeding.
4. Select the calibration mode for specific conductance. Enter the calibration value of the standard being used ( $447 \mu\text{S}/\text{cm}$ ). Allow the temperature and specific conductance to stabilize. If the reading does not change within 30 seconds, press enter to accept the calibration.
5. To check the calibration, select the monitoring/run mode. Remove the probe from the lower standard, rinse the probe with distilled water and then a small amount of the second, higher standard (discard the rinsate), and place the probe into the second, higher ( $718 \mu\text{S}/\text{cm}$  or  $1,413 \mu\text{S}/\text{cm}$ ) standard. The second standard will serve to verify the linearity of the instrument. Read the specific conductance value from the instrument. **Record the value on the calibration log**, and compare the value to the standard. The value must be  $\pm 5\%$ . ( $682\text{--}754 \mu\text{S}/\text{cm}$  for the  $718 \mu\text{S}/\text{cm}$  standard;  $1342\text{--}1484 \mu\text{S}/\text{cm}$  for the  $1413 \mu\text{S}/\text{cm}$  standard). If not, recalibrate using new standards and check again. If the re-calibration does not correct the problem, clean the probe, consult the manufacturer/vendor or replace the unit.
6. Remove probe from the specific conductance check standard, rinse with distilled water, and blot dry.

## OXIDATION/REDUCTION POTENTIAL (ORP)

The oxidation/reduction potential is the electrometric difference measured in a solution between an inert indicator electrode and a suitable reference electrode. The electrometric difference is measured in millivolts and is temperature dependent. A Zobell solution is required to calibrate ORP.

### ORP Calibration Procedure

1. Allow the Zobell solution calibration standard to equilibrate to ambient temperature.
2. Remove the probe from its storage container, and place it into the standard.
3. Select monitoring/run mode.
4. Wait for the probe temperature to stabilize, and then read the temperature. **Record the temperature reading on the calibration log.**
5. Look up the millivolt (mV) value at this temperature from the temperature / millivolt chart found below. These values have been rounded to the nearest whole number. **Record this value on the calibration log.**

**Zobell Solution mV Values Based on Temperature for ORP Calibration**  
**Calibration Check Range Values (+/- 5%)**

Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%
-3	<b>267</b>	254-280	10	<b>251</b>	238-264	23	<b>234</b>	222-246
-2	<b>266</b>	253-279	11	<b>249</b>	237-261	24	<b>232</b>	220-244
-1	<b>265</b>	252-278	12	<b>248</b>	236-260	25	<b>231</b>	219-243
0	<b>264</b>	251-277	13	<b>247</b>	235-259	26	<b>230</b>	219-242
1	<b>262</b>	249-275	14	<b>245</b>	233-257	27	<b>228</b>	217-239
2	<b>261</b>	248-274	15	<b>244</b>	232-256	28	<b>227</b>	216-238
3	<b>260</b>	247-273	16	<b>243</b>	231-255	29	<b>226</b>	215-237
4	<b>258</b>	245-271	17	<b>241</b>	229-253	30	<b>225</b>	214-236
5	<b>257</b>	244-270	18	<b>240</b>	228-252	31	<b>223</b>	212-234
6	<b>256</b>	243-269	19	<b>239</b>	227-251	32	<b>222</b>	211-233
7	<b>254</b>	241-267	20	<b>238</b>	226-250	33	<b>221</b>	210-232
8	<b>253</b>	240-266	21	<b>236</b>	224-248	34	<b>219</b>	208-230
9	<b>252</b>	239-265	22	<b>235</b>	223-247	35	<b>218</b>	207-229

6. Select the calibration mode for ORP. Enter the temperature-corrected ORP value into the instrument. Once the temperature and ORP values stabilize, press enter to accept the calibration.
7. To check the calibration, select the monitoring/run mode. Immerse the probe in the Zobell solution, read the ORP on the instrument. **Record the check value on the calibration log**, and compare the value to the ORP value of the standard in step 5. The instrument value must be  $\pm 5\%$  of the calibration value. See the chart above for the check range. If it is not within  $\pm 5\%$ , recalibrate using a new Zobell solution. If the re-calibration is not successful, consult the manufacture/vendor or replace the unit.
8. Remove the probe from the ORP check standard, rinse with distilled water, and blot dry.

## **TURBIDITY**

The turbidity method is based upon a comparison of intensity of light scattered by a sample under defined conditions with the intensity of light scattered by a standard reference suspension. A turbidimeter is a nephelometer with a visible light source for illuminating the sample and one or more photo-electric detectors placed ninety degrees to the path of the light source.

The low flow procedure requires that the turbidity meter shall have a calibration range from 0.00 to 800 (1000) NTUs.

Some instruments will only accept one standard. For these instruments, additional standards will serve as check points. Turbidity standards concentrations are dependent on expected field conditions. The standards used to calibrate and serve as check points must be within the range expected during that sampling event.

This procedure is based on the use of the Hach 2100P Turbidimeter and the commercially available StablCal® Formazin Primary Turbidity Standards, which is preferred; however, an approved equivalent meter may be used, and the standards may be prepared using Formazin according to the EPA analytical Method 180.1.

### **Calibration Procedures for the Hach 2100P Turbidity Meter**

1. Use the commercially available StablCal® Formazin Primary Turbidity Standards.
2. Before performing the calibration procedure, make sure the cells are not scratched. If the cell is scratched, the standard must be replaced.
3. Allow the calibration standards to equilibrate at the ambient temperature.
4. Turn on the meter.
5. The meter should be in the Auto Range. "Auto Rng" and 0.00 NTUs should show on the



display. If not press the range key until it is in the auto range and reading to two (2) decimal points (i.e. 0.00)

6. Gently invert the standards to thoroughly mix the contents. (**DO NOT SHAKE**)
7. Wipe the standards with a soft, lint free cloth or Kimwipe to make sure the outside surfaces are dry, free from fingerprints and dust.
8. Insert the standard into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.
9. Insert the first (blank) standard, <0.1 NTU, into the cell compartment and close the lid.
10. Press **CAL**. The “CAL” and “S0” icons will be displayed (the “0” will flash).
11. Press **READ**. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the second, 20 NTU standard. The display will automatically increment to the next standard. The display will now show “S1” (with the 1 flashing) and “20 NTU”, the value of the second standard. Remove the <0.1 NTU standard from the compartment.
12. Insert the second, 20 NTU, standard into the cell compartment and close the lid.
13. Press **READ**. The instrument will count from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard with the display showing “S2” (with the 2 flashing) and “100 NTU”, the value of the third standard. Remove the 20 NTU standard from the compartment.
14. Insert the third, 100 NTU, standard into the cell compartment and close the lid.
15. Press **READ**. The instrument will count from 60 to 0, measure the turbidity and store the value. The display will automatically increment to the next standard. The display will show the “S3” (with the 3 flashing) and the 800 NTU standard, the value of the fourth standard. Remove the 100 NTU standard from the compartment.
16. Insert the fourth and last, 800 NTU, standard into the cell compartment and close the lid.
17. Press **READ**. The instrument will count from 60 to 0, measure the turbidity and store the value. Then the display will increment back to the S0 display. Remove the 800 NTU standard from the compartment and close the lid.
18. Press **CAL** to accept the calibration. The instrument will return to the measurement mode automatically.
19. To check the calibration (in run mode), insert the 20 NTU standard into the cell compartment and close the lid.

20. Press **READ**. The meter will display a lamp symbol (which looks like a light bulb) indicating that the reading is in progress. The lamp turns off and the measurement value is displayed. **Record the turbidity reading on the calibration log.** The calibration check must be +/- 5% (19-21 NTUs). If not, recalibrate using all standards. If re-calibration is unsuccessful, use new standards, consult the manufacture/vendor or replace the unit.
21. Remove the 20 NTU check standard from the compartment and close the lid.

## **DATA MANAGEMENT AND RECORDS MANAGEMENT**

All calibration information must be documented on the attached calibration log, including the instrument manufacturer, model number and identification number; standards used to calibrate the instruments (including source); date; personnel; the instrument readings, barometer reading, DO membrane inspection, changed DO membrane and solution, etcetera. Each daily calibration log shall be signed by the user.

## **REFERENCES**

Draft calibration of field instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction potential ~ORP], and turbidity), U.S. Environmental Protection Agency, Region 1, June 3, 1998

Hach Model 2100P Portable Turbidity Instruction Manual

# INSTRUMENT CALIBRATION / MAINTENANCE LOG

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_ **Field Personnel:** \_\_\_\_\_

**Meter: (circle one) YSI:** Model 600XL, Model 6820 **QED:** Model MP 20 **Multimeter Serial Number:** \_\_\_\_\_

**Rental Company:** \_\_\_\_\_

**Probe Pre-cleaned Certification Provided By: Personnel** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Temperature Calibration: Personnel:** \_\_\_\_\_ **Date:** \_\_\_\_\_

**Manufactures Accuracy Range of Sensor (i.e. +/- 0.15°C):** \_\_\_\_\_ **Temperature check results:** \_\_\_\_\_

## Beginning of Day Instrument Calibration

Multimeter Calibration	Value of Standard	Check as Completed	Lot #	Expiration Date	Comments
DO (% saturation)	100%				Allow time for stabilization per manufacture
DO mg/L reading					Record these values immediately after calibration
DO Temp. (°C) reading					
pH 1st Standard	7				
2nd Standard	4				
3rd Standard	10				
Specific Conductance (µS/cm)	447				Lower standard used to calibrate
ORP using Zobell Solution					See Chart on Page 2 for ORP Zobell Solution mV Value Based on Temperature
Zobell Solution _____ °C					

## Additional Information for Dissolved Oxygen Calibration

Barometric Pressure Check: NWS Barometer Location: \_\_\_\_\_ Personnel \_\_\_\_\_ Date: \_\_\_\_\_

NWS Pressure: \_\_\_\_\_ mm Hg Original Hand-held Barometer Pressure \_\_\_\_\_ mm Hg Adjusted to NWS Pressure (circle one) YES or NO

**Barometric Pressure of Meter or Hand Held Barometer :** \_\_\_\_\_ mm Hg [BP inches \_\_\_\_\_ x 25.4 + BP \_\_\_\_\_ mm Hg]

Dissolved Oxygen Charge (if applicable): \_\_\_\_\_ (Acceptable Range: 25 to 75) You MUST change the membrane if charge is out of range.

**Inspected DO membrane for nicks or bubbles (check as completed)** \_\_\_\_\_ **Personnel:** \_\_\_\_\_

**Changed Dissolved Oxygen Membrane and Electrolyte Solution (circle one)** YES or NO

HACH 2100P Turbidimeter Calibration	Value of Standard	Check as Completed	Lot #	Expiration Date	Comments
Turbidity 1st Standard (blank)	<0.1 NTU				Calibrate w/ StablCal® Formazin Primary Turbidity Standards
2nd Standard	20 NTU				
3rd Standard	100 NTU				
4th Standard	800 NTU				

**HACH Serial Number:** \_\_\_\_\_ **Rental Company:** \_\_\_\_\_

## Post A.M. Calibration Check

**Date:** \_\_\_\_\_ **Time:** \_\_\_\_\_ **Personnel:** \_\_\_\_\_

Calibration Check	Value of Standard	Check Results	Acceptable Range	Within Range (yes/no)	Lot #	Expiration Date	Comments
Zero DO check (mg/l)	0		< 0.5 mg/L				
pH 7 check	7		+/- 5%				Range 6.65 - 7.35 pH
Specific Conductance (µS/cm)	718 or		+/- 5%				Range 682 - 754 µS/cm (718)
Higher standard used for check	1413						Range 1342 - 1484 µS/cm (1413)
ORP check - Zobell (mV)			+/- 5%				See Chart on Page 2 for Range
Turbidity 2nd Standard (NTU)	20		+/- 5%				Range 19.0 - 21.0 NTU

**Notes:** 1.) NWS = National Weather Service

2.) If the post calibration check is not within the acceptable range the meter must be recalibrated.

3.) All calibration checks must be made in the run mode, not the calibration mode.

Calibration & Post Calibration Check Performed by: \_\_\_\_\_ (Print) \_\_\_\_\_ (Sign)

END OF DAY INSTRUMENT CALIBRATION CHECK							
Calibration Check	Value of Standard	Check Results	Acceptable Range	Within Range (yes/no)	Lot #	Expiration Date	Comments
Date: _____ Time: _____		Personnel: _____					
Zero DO check (mg/l)	0		< 0.5 mg/L				
pH 7 check	7		+/- 5%				Range 6.65 - 7.35 pH
Specific Conductance ( $\mu\text{S}/\text{cm}$ )	718 or		+/- 5%				Range 682 - 754 $\mu\text{S}/\text{cm}$ (718)
Higher standard used for check	1413						Range 1342 - 1484 $\mu\text{S}/\text{cm}$ (1413)
ORP check - Zobell (mV)			+/- 5%				See Chart Below for Range
Turbidity 2nd Standard (NTU)	20		+/- 5%				Range 19.0 - 21.0 NTU

**Notes:**

- 1.) If the end of the day calibration check is not within the acceptable range the data collected that day for that parameter shall be qualified in it's use.
- 2.) All calibration checks must be made in the run mode, not the calibration mode.

Calibration Check by \_\_\_\_\_  
Print Name

\_\_\_\_\_  
Signature

List wells sampled using this equipment on this day if data needs to be qualified

---

---

---

---

---

---

---

---

Zobell Solution mV Value Based on Temperature for ORP Calibration								
Calibration Check Range Values (+/- 5%)								
Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%	Temp. °C	ORP Zobell Solution mV Value	Calibration Check Range Values +/- 5%
-3	267	254-280	10	251	238-264	23	234	222-246
-2	266	253-279	11	249	237-261	24	232	220-244
-1	265	252-278	12	248	236-260	25	231	219-243
0	264	251-277	13	247	235-259	26	230	219-242
1	262	249-275	14	245	233-257	27	228	217-239
2	261	248-274	15	244	232-256	28	227	216-238
3	260	247-273	16	243	231-255	29	226	215-237
4	258	245-271	17	241	229-253	30	225	214-236
5	257	244-270	18	240	228-252	31	223	212-234
6	256	243-269	19	239	227-251	32	222	211-233
7	254	241-267	20	238	226-250	33	221	210-232
8	253	240-266	21	236	224-248	34	219	208-230
9	252	239-265	22	235	223-247	35	218	207-229

## **CHAIN-OF-CUSTODY, SAMPLE HANDLING & SHIPPING**

### **PURPOSE**

This Standard Operating Procedure (SOP) has been established to provide for sample integrity including proper sample labeling, completion of Chain-Of-Custody (COC) forms, sample packaging and shipment.

A COC is a legal document designed to track persons who are responsible for sample collection, delivery, storage, and analysis. The field sampler is personally responsible for the care and custody of the samples, including un-used sample containers, until they are transferred or properly dispatched. As few people as possible should handle the samples.

**Never leave samples, including un-used sample containers, unattended. All samples and un-used sample containers must be in the person's possession or placed in a locked location at all times.**

All samples submitted to a laboratory shall be accompanied by a properly completed COC form, packaged and shipped as appropriate. Always check with the project manager and the selected laboratory for specific requirements regarding COCs. A copy of the current NHDES COC form is attached.

Failure to maintain possession in the ways outlined in this SOP would constitute a break in sample custody and would likely discredit this sample as use of evidence in court proceedings. The sampler must assume that all samples collected will some day be used as evidence in court and treat the task of sample custody accordingly.

### **EQUIPMENT AND MATERIALS**

The following is a list of equipment and material commonly used for labeling, packaging and shipping samples:

- Chain of custody forms/seals;
- Bubble wrap or air cushions and packing;
- Re-sealable plastic bags;
- Permanent waterproof ink marker;
- Black ink pen;
- Ice;
- Shipping coolers;
- Sample labels; and
- Tape

## CUSTODY PROCEDURES

1. The field sampler will review the Sampling and Analysis Plan (SAP) and consult the project manager for specific COC requirements such as:
  - Specific Quality Assurance/Quality Control (QA/QC) data validation packages;
  - Laboratory reporting options, including preliminary results or electronic deliverables;
  - Standard or rush turn-around-times; and
  - Special laboratory requirements including lower detection limits; short hold times; and sample volume issues.
2. The field sampler will label all sample bottles, using waterproof ink, with the following information at a minimum:
  - a. Sample ID;
  - b. Site name/location;
  - c. Sampler name;
  - d. Date and time sample was collected;
  - e. Laboratory analysis and test method requested; and
  - f. Preservative used.

**Note: If soil VOA samples are collected, no additional labels or tape should be used as these are pre-weight by the laboratory.**

3. Prior to leaving the site, the field sampler will check for errors on the sample label and COC form and verify that all pertinent data is present and correct.
4. The COCs will be filled out and include the following information at a minimum:
  - a. The site/project name
  - b. Town the site is located in;
  - c. Appropriate activity/project number (NHDES site number);
  - d. Unique sample IDs;
  - e. Time and date of collection;
  - f. Matrix type;
  - g. Laboratory analysis and method requested;
  - h. Number of containers;
  - i. Preservatives;
  - j. Name and phone numbers of all samplers and staff involved in filling out the COC forms;

- k. Name and phone number of the Project contact person;
  - l. Specific requirements such as specific Reporting Detection Limits (RDLs);
  - m. Any special notes or requirements such as the lab account number, One Stop (Project) ID#, etc.; and
  - n. All QA/QC samples and associated information (i.e., trip, temperature and equipment blanks, duplicates, etc).
5. When transferring the possession of samples, the person(s) responsible for custody of the samples from the time the sample was collected until it was checked into the lab must sign in the "Relinquished by" section. Pre-approved NHDES personnel may relinquish the samples to "locked storage" in the NHDES Lab. The receiving official must sign in the "Received by" section. All signatures must be in ballpoint pen and are followed by a date and time of signing. This record documents transfer of custody of samples from the sampler to another person, laboratory, or a secure storage area.
- Note: Any errors must be lined out and initialed, and the correction written in.**
6. The project manager will review the COC to evaluate completeness; holding time or sample volume issues that may impact the validity of the results.

## **SAMPLE PACKAGING PROCEDURES**

After collection, all samples shall be transported to the laboratory in such a manner as to prevent breakage and preserve sample integrity. Sample containers are generally packaged in insulated coolers.

- 1. All samples, including QA/QC samples (trip blanks, etc), shall be placed in a cooler in **loose ice** to ensure temperature preservation of  $4 \pm 2^{\circ}\text{C}$  is achieved.
- 2. All samples shall be placed in an upright position and in such a manner as to prevent cross contamination due to leakage or breakage.
- 3. A completed COC in a sealed Ziploc bag shall be included within each cooler.

## **SAMPLE PICKUP/SHIPPING PROCEDURES**

Field personnel will coordinate directly with the appropriate laboratory for delivery times and requirements. Whenever possible, all samples will be checked into the laboratory performing the analyses on the same day the samples are collected. If it is impossible to check in samples at the laboratory the same day, the samples shall be placed in a secure area, following appropriate protocol for sample preservation (such as cooling to  $4 \pm 2^{\circ}\text{C}$ ) and the field team will be responsible for proper secure storage of samples until the samples are delivered to the laboratory or handed over to a courier.

Samples shall be properly packaged in a cooler for shipment to maintain sample integrity and

delivered to the analytical laboratory along with a separate signed COC form enclosed in each sample cooler. Samples must be delivered in a manner consistent with the requirements of the analytical laboratory with respect for preservation, temperature, holding times for the particular analytes to be tested.

### **Sample Pickup/Delivery**

Samples are either delivered directly to the laboratory by the field team or the laboratory provides a courier to transport them. Custody seals shall be used when the cooler is sent to the laboratory by independent courier, unless otherwise specified in the site specific Sampling and Analysis Plan (SAP).

### **Shipping Samples to the Laboratory**

When samples need to be shipped, they are typically sent next-day delivery by Federal Express or an equivalent overnight carrier. Field personnel will coordinate directly with the appropriate laboratory in advance for delivery times and requirements and will notify the laboratory prior to sample shipment. Coolers will be secured with strapping tape in at least two locations for shipment and include a custody seal. If the sample is considered hazardous, consult appropriate trained office personnel for proper packaging and labeling.

If the samples are shipped by public courier (if Federal Express, UPS, etc.) the airbill generally serves as the chain-of-custody record for that portion of the trip and will be retained by the field sampler (and provided to the project manager) as part of the permanent documentation.

### **DOCUMENTATION**

The original COC record will accompany the cooler and a copy will be retained by the sampler for return to the project manager.



# NH DES LABORATORY SERVICES LOGIN AND CUSTODY SHEET

(Laboratory Policy: Samples not meeting method requirements will be analyzed at the discretion of the NH DES Laboratory.)

LAB ACCOUNT (Billing) # \_\_\_\_\_ One Stop (PROJECT) ID# \_\_\_\_\_ DES Site Number \_\_\_\_\_ Temp. ° C. \_\_\_\_\_

Description: \_\_\_\_\_ Town: Troy NH NHDES Contact & Phone#: \_\_\_\_\_

Comments: Temperature Blank included yes or no (Please circle) Contractor Contact & Phone # \_\_\_\_\_

Collected By & Phone#: \_\_\_\_\_

Sample Location /ID	Date/Time Sampled	# of Containers	Matrix															Other / Notes	Lab ID # ( For Lab Use Only )

Preservation: \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date and Time \_\_\_\_\_ Received By \_\_\_\_\_ Matrix: A= Air S= Soil SED = Sediments AQ= Aqueous Other: \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date and Time \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date and Time \_\_\_\_\_ Received For Laboratory By \_\_\_\_\_

Page \_\_\_\_\_ of \_\_\_\_\_

Data Reviewed By \_\_\_\_\_ Date \_\_\_\_\_

Section No.: 22.0  
Revision No.: 5 (HWRB)  
Date: 11-2-06  
Page 1 of 1

# **NHDES SOP**

## **Preservation of VOCs in Soil Samples**

**Please note that the links found in appendix A and B in the original document below, dated March 2000 have not been updated.**

**Below are current links to EPA Method 5035 and the Massachusetts Preservation Techniques for Volatile Organic Compound (Voc) Soil Sample Analyses Policy WSC # 99-415**

### **Appendix A**

#### **ASTM D 4547-98 and EPA Method 5035**

<http://www.epa.gov/epaoswer/hazwaste/test/pdfs/5035.pdf>

[http://www.epa.gov/epaoswer/hazwaste/test/pdfs/5035a\\_r1.pdf](http://www.epa.gov/epaoswer/hazwaste/test/pdfs/5035a_r1.pdf)

### **Appendix B**

#### **Massachusetts Policy and Article**

<http://www.mass.gov/dep/cleanup/laws/99-415.pdf>



# **FINAL POLICY**

## **PRESERVATION OF VOCs in SOIL SAMPLES**

MARCH 2000

# **Soil Sampling for VOC Analysis Policy**

## **1.0 INTRODUCTION**

This New Hampshire Department of Environmental Services (DES) “Soil Sampling for VOC Analyses” guidance document contains recommendations for soil sampling protocols for all petroleum and hazardous waste sites. The protocols are applicable to all soil samples analyzed for volatile organic compounds (VOC). This guidance was developed in response to a preponderance of scientific evidence indicating the under-reporting of VOC concentrations due to VOC loss during sample collection and storage. The three main mechanisms responsible for the VOC loss are: 1) initial sampling and sub-sampling activities that disturb/destroy soil structure and/or aerate samples, 2) volatilization/diffusion out of the sample container during storage and 3) biodegradation of contaminants during storage.

The EPA has issued soil VOC sampling and analysis methodology [SW 846 Method 5035 (December 1996)]. ASTM has also adopted a standard for low VOC loss sampling [ASTM Standard D4547-98 (Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds)]. In these methods (see Appendix A), methanol is added immediately to the sample while in the field to preserve the soil sample. Region IV and a number of states, including Alaska, Massachusetts, Minnesota, New Jersey, New Mexico, Pennsylvania, South Carolina and Wisconsin, have adopted policies requiring methanol preservation of soil samples containing VOCs. In Massachusetts the methanol preservation requirement was established on October 31, 1997 for the Volatile Petroleum Hydrocarbon (VPH) analysis method and on March 5, 1999 for all soil samples subject to VOC analysis (Preservation Techniques for Volatile Organic Compound (VOC) Soil Sample Analyses: WSC #99-415). The Massachusetts Policy and a general article on VOC loss from samples are included in Appendix B.

DES believes that the availability of specialized soil VOC sample containers with pre-measured methanol and the recent development of alternative low VOC loss sample devices/containers minimizes the costs and logistical requirements for implementing this new sampling approach.

## **2.0 APPLICABILITY**

Sampling protocols contained in this document are required for all soil samples that will be analyzed for VOCs by EPA SW 846 Methods 8015A, 8021B, 8260B or equivalent EPA Standard Methods procedures. The sampling protocols should also be used whenever VOC loss can significantly affect the accuracy of the results, such as the analysis of gasoline contaminated soil for TPH. The policy does not apply to onsite mobile laboratory analyses, when samples are collected and analyzed the same day. The policy also does not apply to field screening methodologies, such as PID/FID headspace screening, UV Fluorescence & Adsorption, Immunoassay Test Kits or portable GC units that are used on a real time basis. All other data obtained from a sampling methodology that does not follow this policy will be considered to be improperly preserved and not scientifically valid. DES may reject the results and require resampling when the soil sampling protocols in this policy are not properly followed. No phase-in of the policy is

recommended because of the general availability of the required sampling equipment, and the familiarity of the laboratories in the region with the required methodologies due to the similarity with Massachusetts' policy. This policy will become effective March 30, 2000.

### **3.0 PREVIOUSLY OBTAINED OR SUBMITTED DATA**

The following table describes how unpreserved VOC soil data will be managed, based upon the sample collection and the report submission date.

<b>Sample Collection Date</b>	<b>Data Submission Date</b>	<b>Comments</b>
Before 3/30/2000	Before 3/30/2000	DES will not reopen sites that were closed based on previous sampling practices, unless new data or information becomes available. DES may require reevaluation of data at active sites, if evidence exists that may be significant health and environmental concerns. Factors that will be considered when making a decision to reevaluate existing data are listed below.
Before 3/30/2000	On or after 3/30/2000	Consultants and site owners should evaluate the data and site characterization to determine whether loss of VOCs is a significant issue. The report should discuss the sampling protocols that were used and recommend whether the soil should be resampled.
After 3/30/2000	On or after 3/30/2000	Proper preservation techniques must be used, or DES will not accept the data. The petroleum reimbursement funds will not reimburse for the cost of the analysis of samples that were collected improperly. Change orders for related costs can be submitted to the reimbursement program for work scopes submitted prior to implementation of the policy.

#### **Data Evaluation Factors**

1. VOC headspace and other screening data indicate significant levels of VOCs;
2. The type, toxicity and persistence of VOCs present (e.g., Chlorinated compounds and MtBE generally pose a greater long term threat to groundwater and the environment);
3. High and/or consistent levels of VOCs in groundwater indicate that VOCs in soil may be a continuing source; or
4. The presence of sensitive receptors or exposure pathways at or in the vicinity of the disposal site.

### **4.0 METHODOLOGY**

The methodology in ASTM Standard D4547-98 or EPA Method 5035 should be followed for the collection of all VOC samples. These methods provide additional, valuable guidance on sampling protocols, for example, procedures necessary to successfully sample oily wastes. DES believes that in the vast majority

of cases samples can be collected using the following two soil preservation techniques discussed in ASTM D4547-98 and EPA Method 5035: 1) field preservation with methanol and 2) the use of a low VOC loss sampling system such as the EnCore<sup>TM</sup> sampler or equivalent. The DES requires that the laboratory report a minimum wet weight estimated quantitation limit of 100 µg/kg for these two methods.

A third methodology can potentially be used to achieve a lower VOC detection limit (<100 µg/kg). This method is known as the low level or sodium bisulfate preservation technique. DES notes that only the following twelve VOC contaminants have S-1 soil cleanup standards equal to or below the <100 µg/kg detection limits achievable by methanol preservation: acrylonitrile, bromodichloromethane, bromoform, chloroform, dibromochloromethane, dibromochloropropane, 1,2-dichloroethane, 1,2-dichloropropane, ethylene dibromide, methylene chloride, 1,1,2,2-tetrachloroethane and 1,1,2-trichloroethane. All of the S-1 soil standards for these compounds were based on a potential threat to groundwater, not direct contact risk. As a result, it is not necessary to achieve the lower detection limit using the sodium bisulfate preservation technique, if data exists indicating that groundwater impacts have not occurred. It should be noted that the bisulfate method has the following shortcomings: a) special equipment is required at the laboratory, b) the sodium bisulfate may react with humic compounds to generate acetone and 2-butanone, c) the sample will effervesce when carbonates are present and d) more complex field protocols are required. DES, as a result, does not recommend the use of the sodium bisulfate preservation technique, unless the lower detection limit is absolutely necessary to identify groundwater contamination source areas containing one of the twelve contaminants with S-1 standards less than or equal to 100 µg/kg.

DES will consider other low VOC loss sampling protocols beyond the three discussed in this document on a case-by-case or site-specific basis. DES approval is required prior to sample collection for any other low VOC loss protocol that is not specifically discussed in this policy.

#### 4.1 Methanol Preservation

The methanol preservation technique must be performed in the field and involves the following key steps:

- Collection of 5 to 25 grams of soil. Typically the lab will mark a level on the bottle that indicates the volume that should result after the addition of the soil to the methanol. A duplicate sample should be collected, in case the sample analysis must be rerun. Additional samples may need to be collected based on site-specific QA/QC requirements (i.e., matrix spike, matrix spike duplicate, etc.)
- Addition of “purge and trap” grade or equivalent methanol to the sample vial at a desired ratio of 1:1 (grams soil/mL methanol). The tolerance for this ratio is +/- 25%. Ratios outside of this range may be acceptable, depending on data quality objectives. Soil samples must be completely immersed in methanol.
- It is not necessary to weigh the sampled soil in the field as long as the weight of the soil can be calculated and the soil weight/volume ratio is +/- 25% of the acceptable 1:1 ratio. There are a number of soil sample collection devices available to facilitate accurate collection of the required

volume of sample.

- An additional unpreserved sample must be collected to allow for a determination of moisture content. Without the additional sample, the laboratory cannot report the results on a dry-weight basis. Moisture effects may become significant at moisture contents greater than 25%. When moisture content is greater than 25%, data reports should discuss the implications of sample dilution resulting from the high moisture content.
- The sample must be analyzed by an EPA or New Hampshire accredited laboratory.

DES prefers the use of sampling bottles obtained from the laboratory with pre-measured quantities of methanol. This will ensure that appropriate purity methanol is used and minimizes handling of methanol by field personnel. DES also recommends using a volumetric sampling device to collect the soil sample. This minimizes the loss of VOCs during sample collection and eliminates the need to weigh samples in the field. Sample containers should not remain open for long periods of time to minimize the potential for cross contamination of the sample and the loss of methanol. Please refer to ASTM D4547-98 and EPA Method 5035 for additional information about proper sampling technique and the sodium bisulfate method (if site specific circumstances warrant its use).

#### 4.2 Alternate Sampling Methods

An EnCore<sup>TM</sup> sampler or similar DES approved device with proven effectiveness may be used to obtain samples in the field without preservation, provided that the sample is extruded into methanol or extracted by a laboratory within 48 hours of sample collection. The sampler must follow the manufacturer's directions for the sampling device used and all other appropriate sample preservation protocols, such as keeping samples at or below 4° C. Information on the use of EnCore<sup>TM</sup> samplers is included in ASTM 4547-98 in Appendix A.

### **5.0 SAMPLE COMPOSITING**

Composite samples can be collected using the methanol method of sampling. To accomplish this, grab samples would be collected in accordance with the methodology discussed in section 4.1 of this policy. The laboratory then prepares the composite sample by using a syringe to collect equal amounts of the methanol preserved sample from each of the vials. The subsamples are then combined to yield the required composite sample volume.

An alternate approach to collecting composite samples that does not require compositing of the samples at the laboratory is to use a large VOC vial with septum lid. Methanol is added to the VOC vial in proportion with the number of samples that will be composited to ensure that the desired ratio of 1:1 (grams soil/mL methanol) is maintained. For example, 25 ml of methanol would be added to composite five, 5 gram soil samples. All of the soil samples that are to be composited are then added to the VOC vial containing the methanol with care exercised to prevent methanol from splashing out of the vial.

Soils that are proposed for reuse onsite must be analyzed using a low VOC loss composite sampling methodology such as this, or by representative low VOC loss grab sampling. DES does not require that this policy be used for the purposes of characterizing soil for an offsite disposal facility. It is necessary to use the sampling approach discussed in this policy, however, if the data will be used for both offsite site disposal facility purposes and remedial decision making on whether the soil can remain onsite.



**Appendix A**  
**ASTM D 4547-98 and EPA Method 5035**

**Appendix B**  
**Massachusetts [Policy](#) and Article**

**NHDES SOP**  
**The Vapor Intrusion Guidance Document**  
**July 2006**

**Replaces the NHDES SOP**  
**NHDES Residential Indoor Air Assessment Guidance**  
**Document**

**Table 1**  
**Vapor Intrusion Screening Levels**  
**revised February 1, 2007**  
**See first page below**

**New Hampshire Department of Environmental Services  
Waste Management Division Site Remediation Programs**

**Table 1  
Vapor Intrusion Screening Levels**

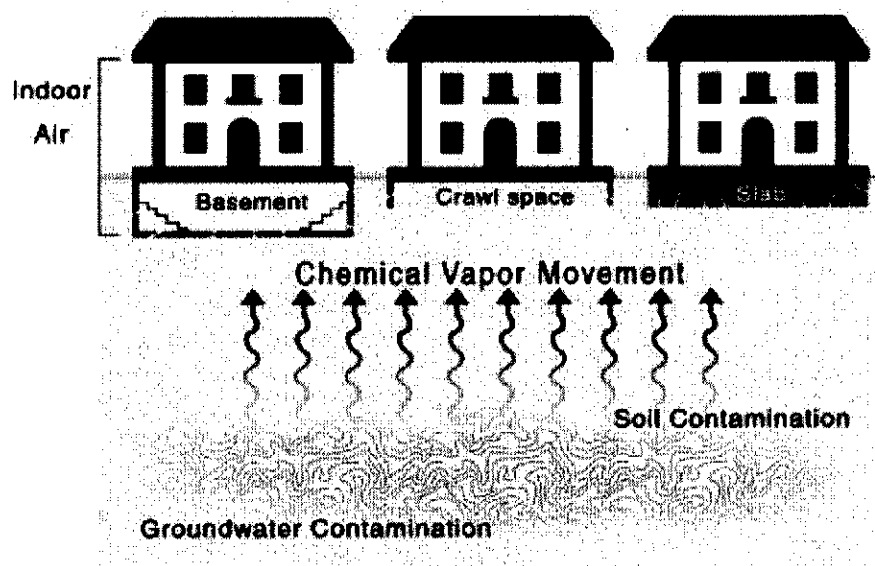
Chemical	Residential Indoor Air Screening Levels  (µg/m <sup>3</sup> )	Commercial Indoor Air Screening Levels  (µg/m <sup>3</sup> )	Residential Soil Gas Screening Levels  (µg/m <sup>3</sup> )	Commercial Soil Gas Screening Levels  (µg/m <sup>3</sup> )	Groundwater to Indoor Air Screening Levels  GW-2(1) (µg/L)
Benzene	1.9 <sup>(2)</sup>	1.9 <sup>(2)</sup>	95	95	2,000
Bromoform	2.4	11	120	550	2,000
Bromomethane	1.0	1.5	50	73	10
Carbon Tetrachloride	1.3 <sup>(3)</sup>	1.3 <sup>(3)</sup>	63	63	40
Chlorobenzene	10	15	500	730	2,000
Chloroform	1.0 <sup>(3)</sup>	1.0 <sup>(3)</sup>	49	49	100
Dichlorobenzene, 1,2-	40	58	2000	2900	20,000
Dichlorobenzene, 1,4-	160	230	8000	12000	50,000
Dichloroethane, 1,1-	100	150	5000	7300	10,000
Dichloroethane, 1,2-	0.8 <sup>(3)</sup>	0.8 <sup>(3)</sup>	40	40	300
Dichloroethylene, 1,1-	40	58	2000	2900	1,000
Dichloromethane (Methylene Chloride)	5.6 <sup>(2)</sup>	26	280	1300	1,000
Dichloropropane, 1,2-	0.9 <sup>(3)</sup>	1.2	46	59	200
Ethylbenzene	200	290	10000	15000	50,000
Ethylene dibromide	1.5 <sup>(3)</sup>	1.5 <sup>(3)</sup>	77	77	700
Methyl ethyl ketone	1000	1500	50000	73000	50,000
Methyl isobutyl ketone	600	880	30000	44000	50,000
Methyl tert butyl ether (MTBE)	5.6 <sup>(2)</sup>	15	280	770	10,000
Naphthalene	2.6 <sup>(3)</sup>	2.6 <sup>(3)</sup>	130	130	2,000
Styrene	200	290	10000	15000	50,000
Tetrachloroethane, 1,1,2,2-	1.4 <sup>(3)</sup>	1.4 <sup>(3)</sup>	69	69	1,000
Tetrachloroethylene (PCE)	1.4 <sup>(3)</sup>	2.1	68	100	80
Toluene	1000	1500	50000	73000	50,000
Trichlorobenzene, 1,2,4-	3.7 <sup>(3)</sup>	3.7 <sup>(3)</sup>	190	190	1,000
Trichloroethane, 1,1,1-	440	640	22000	32000	20,000
Trichloroethane, 1,1,2-	1.1 <sup>(3)</sup>	1.1 <sup>(3)</sup>	55	55	500
Trichloroethylene (TCE)	1.1 <sup>(3)</sup>	1.1 <sup>(3)</sup>	54	54	90
Trimethylbenzene, 1,2,4-	4.3 <sup>(2)</sup>	4.3 <sup>(2)</sup>	220	220	3,000
Trimethylbenzene, 1,3,5-	1.7 <sup>(2)</sup>	1.8	85	88	1,000
Vinyl chloride	0.5 <sup>(3)</sup>	2.8	26	140	10
Xylenes (mixed isomers)	20	29	1000	1500	30,000

(1) Revised Risk Characterization and Management Policy GW-2 values.

(2) The screening values for these compounds are based on published background values.

(3) The risk based levels for these compounds are below the EPA TO-15 low level reporting limit and therefore the screening value is based on method reporting limit.

# Vapor Intrusion Guidance



(EPA Region 3)

July 2006



# Vapor Intrusion Guidance

Prepared by  
Site Remediation Programs  
Waste Management Division  
New Hampshire Department of Environmental Services  
29 Hazen Drive  
Concord, NH 03302-0095  
[www.des.nh.gov](http://www.des.nh.gov)  
(603) 271-3503

Michael P. Nolin, Commissioner  
Michael J. Walls, Assistant Commissioner  
Anthony P. Giunta, Director, Waste Management Division

July 2006





# Table of Contents

SECTION TITLE	PAGE
1.0 PURPOSE .....	1
2.0 HOW VAPOR INTRUSION OCCURS	
2.1 General Concepts.....	1
2.2 Factors that Affect Vapor Intrusion .....	2
3.0 EVALUATING THE VAPOR INTRUSION PATHWAY	
3.1 General Considerations .....	3
3.2 Method 1 Approach. ....	4
3.3 Site Specific Pathway Assessment .....	6
4.0 METHOD 1 VAPOR INTRUSION SCREENING LEVELS	
4.1 Groundwater Screening Levels.....	6
4.2 Soil Gas Screening Levels....	7
4.3 Indoor Air Screening Levels .....	7
5.0 SOIL GAS SAMPLING PROCEDURES	
5.1 Overview ....	8
5.2 Designing a Soil Gas Sampling Plan.....	8
5.3 Field Screening .....	9
5.4 Soil Gas Probes.....	9
5.5 Sample Collection and Analysis .....	10
5.6 Soil Gas Data Evaluation .....	13
6.0 INDOOR AIR SAMPLING	
6.1 General Approach.....	13
6.2 Site Inspection, Product Inventory and Field Screening.....	14
6.3 Sample Collection and Analysis .....	14
6.4 Background. ....	15
6.5 Sampling under Conservative Conditions.....	16
6.6 OSHA Considerations .....	17
7.0 EVALUATION OF RESULTS....	17
8.0 ADDITIONAL INVESTIGATIVE TOOLS	
8.1 Determination of a Site-specific Soil Gas Attenuation Factor . ....	19
8.2 Indoor/sub-slab Differential Pressure Measurements.. ....	19
8.3 Passive Soil Gas.....	20
8.4 Flux Chambers.....	20
8.5 Modeling.....	20
9.0 VAPOR INTRUSION ABATEMENT STRATEGIES.....	21
10.0 REFERENCES ..	23



## **TABLES**

Table 1	Vapor Intrusion Screening Levels .....	25
---------	--	----

## **FIGURES**

Figure 1	Simplified Vapor Intrusion Conceptual Model .....	2
Figure 2	Evaluating the Vapor Intrusion Pathway .....	26
Figure 3	Soil Gas Sampling Probes .....	10
Figure 4	Permanent Soil Gas Probe ....	11
Figure 5	Sub-slab Soil Gas Probe .....	11
Figure 6	Sub-slab Soil Depressurization System .....	22

## **APPENDICES**

APPENDIX A	Vapor Intrusion Conceptual Site Model Checklist .....	27
APPENDIX B	Soil Gas Probe Field Data Report .....	29
APPENDIX C	Indoor Air Sampling Form .....	30
APPENDIX D	Indoor Air Sampling Protocol ....	33
APPENDIX E	Derivation of the Indoor Air Screening Levels.. ..	36

## **1.0 PURPOSE**

This document provides guidance for the evaluation and mitigation of vapor intrusion resulting from volatile organic compounds (VOC) at contaminated sites in New Hampshire. Where appropriate this document may be used in conjunction with applicable DES rules for corrective action at contaminated sites and the DES Risk Characterization and Management Policy (RCMP).

An often overlooked exposure pathway involves VOC vapor movement from contaminated soil and/or groundwater and residual or mobile non-aqueous phase liquid (NAPL) through the subsurface into nearby buildings where occupants can be exposed. Commonly referred to as the vapor intrusion pathway, this pathway can be complicated to evaluate in terms of assessing risk to human health as there are many factors that influence the migration of vapors in the subsurface. This document provides the following:

- A review of basic vapor intrusion concepts.
- A discussion of a multiple line of evidence approach for assessing the pathway.
- A review of DES screening levels for groundwater, soil gas and indoor air.
- A review of soil gas sampling techniques.
- A review of indoor air sampling techniques.
- A review of vapor intrusion abatement strategies.
- An approach for conducting a site-specific risk assessment.
- A list of references.

## **2.0 HOW VAPOR INTRUSION OCCURS**

### **2.1 General Concepts**

Vapor intrusion occurs when VOCs migrate from contaminated soil and/or groundwater or residual or mobile NAPL through the subsurface to the indoor air of a building. This pathway can also be a potential issue for future buildings located above or near VOC contamination. Vapor intrusion sites can involve petroleum contaminants from leaking underground storage tanks and spills as well as chlorinated solvents and pesticides from commercial, industrial and landfill sites. This policy does not specifically address issues associated with landfill gases such as methane; however some of the same assessment and mitigation techniques may be appropriate for those sites. Vapor intrusion related to non-VOCs such as mercury, are not specifically addressed in this policy and would continue to be handled on a case by case basis.

In general, VOC vapor intrusion sites are grouped into two categories: petroleum hydrocarbons and chlorinated solvents. Projects involving vapor intrusion of chlorinated solvents have the potential to be more complicated to evaluate than petroleum contaminants because of their greater mobility, the lack of good warning properties such as low odor thresholds, and limited potential to undergo biodegradation.

Figure 1 below presents a simplified vapor conceptual site model of a scenario where the source of contamination is located some distance from an occupied structure. At the top boundary of the subsurface contamination, molecular diffusion results in the movement of chemicals from areas of higher concentration to lower concentration. The contaminant vapors diffuse up towards

the structure until reaching the building's zone of influence. Once the VOCs enter the building's zone of influence differential pressure gradients control the vapor movement in the proximity of the structure. Since the air pressure inside a structure is commonly less than the pressure in the subsurface, the vapor migrates by bulk air flow (advection) through cracks or openings (e.g., floor drains) in the foundation or basement slab into the structure in response to "inward" pressure gradients. Advection can be induced by atmospheric pressure fluctuations and stack effects due to building heating and mechanical ventilation systems. Negative pressure gradients (i.e., lower air pressure inside a structure versus soil vapor pressure) can be greatest when heating systems are in operation. Advection is likely the dominant process near a structure.

Diffusion, which is the concentration gradient-driven migration, is commonly accepted to be the dominant process away from the building foundation or where the water table is shallow and the soil adjacent to the foundation is mostly water saturated. Where preferential pathways exist, the vapor conceptual site model shown below would be different.

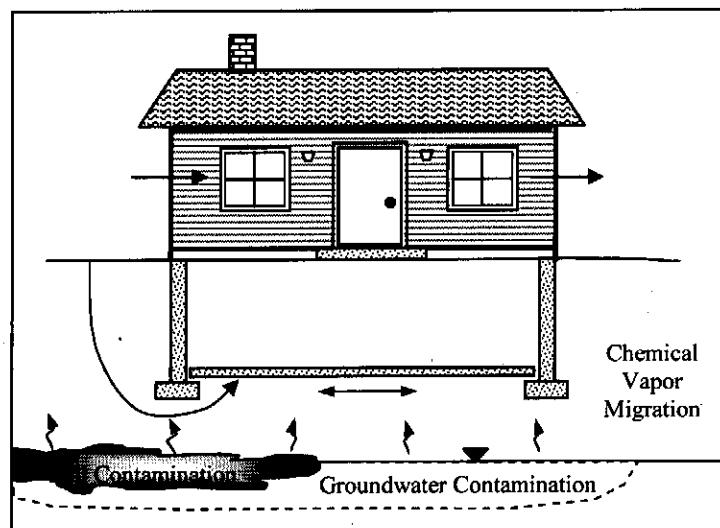


Figure 1. Simplified vapor intrusion conceptual model

## 2.2 Factors That Affect Vapor Intrusion

Many factors can influence contaminant vapor movement in the subsurface and potentially cause a human health risk to a building occupant. Conditions that influence vapor intrusion can include:

- Construction style – Vapor intrusion occurs in structures with or without basements. Investigation of sites in other states has found that even slab-on-grade construction can be affected by vapor intrusion. The condition and construction of the foundation and presence/absence of an adequate vapor barrier can be important factors to consider. Positive pressure HVAC systems can prevent vapor intrusion.
- Structure age – Older structures are less likely to have adequate vapor barriers incorporated into the foundation construction and the foundation itself is more likely to have developed cracks.

- Dirt floors and stone foundations – Earthen floors or fieldstone foundations are more porous and provide increased opportunity for vapor intrusion.
- Drain tile/sumps – If the building has a foundation drain tile connected to a sump even low level VOC concentrations in the water can contribute to indoor air problems.
- Wet basements – If the building has water infiltrating into the basement dissolved VOCs can volatilize into the indoor air. Wet basements can indicate a shallow water table or be related to drainage problems.
- Utility lines – Gaps or cracks around piping or other utility lines that enter a building can be an important preferential migration pathway for vapors. Permeable soil in a utility trench can also provide a conduit for contaminants to migrate significant distances from the source area.
- Proximity of contamination to buildings – Vapor intrusion should be an obvious concern when buildings are very close to the source of VOC contamination.
- Shallow groundwater – The potential for vapor intrusion typically decreases with increasing depth to groundwater for some chemicals particularly those that are known to biodegrade such as petroleum hydrocarbons.
- Soil type and moisture content– Soil type influences the transport of contaminants in soil vapor and groundwater. Coarse-grained soil types can promote contaminant migration over long distances, but also provides easier venting to the atmosphere. Fine grained or tight soils with higher moisture content will tend to inhibit vapor contaminant transport. The soil stratigraphy is also important in developing a conceptual site model of soil gas migration.
- Fractured bedrock – Shallow fractured bedrock connected to a subsurface source of VOCs can increase vapor intrusion potential by encouraging faster soil gas migration. This becomes a greater concern when the bedrock is at or near the base of a building foundation.
- Degradation – Petroleum hydrocarbons can biodegrade relatively quickly in unsaturated soils. In contrast chlorinated solvents will likely undergo limited biodegradation and, therefore, may have the ability to cause a vapor intrusion impact a long distance away from the VOC source.

### **3.0 EVALUATING THE VAPOR INTRUSION PATHWAY**

#### **3.1 General Considerations**

DES recommends that the vapor intrusion pathway be evaluated at sites where there is a source of VOC contamination near an occupied building(s). VOC contaminated groundwater is considered to be a potential source of vapors of contaminants to indoor air. The GW-2 groundwater screening values are intended to provide guidelines on when it may be appropriate to examine the indoor air exposure pathway. The GW-2 groundwater screening values are intended to be used where VOCs (non-petroleum) are detected in groundwater above the GW-2 levels within 100 feet (vertically or horizontally) of an occupied building. At petroleum hydrocarbon sites, the GW-2

screening values are intended to be applied where petroleum VOCs are detected in groundwater above the GW-2 levels within 30 feet (vertically or horizontally) of an occupied building.

In order to evaluate the potential for vapor intrusion into buildings, DES recognizes two methods for evaluating the vapor intrusion pathway. The first is a Method 1 approach using screening levels where multiple lines of evidence are obtained to determine if the vapor intrusion pathway is complete, and if so, whether there is a significant risk to building occupants. The Method 1 approach includes screening levels for groundwater, soil gas, and indoor air. The second approach is a site-specific vapor intrusion pathway assessment. The two methods for evaluating the vapor intrusion pathway are discussed in more detail in Sections 3.2 and 3.3 below.

Vapors emanating from contaminated groundwater at some depth below a building are not the only VOC sources that may result in an indoor air exposure. The scenarios listed below can also result in an indoor air exposure with or without exceeding a GW-2 screening value. It may be appropriate to evaluate the vapor intrusion pathway for the following scenarios:

- Where a vadose zone VOC source from contaminated soil or a vapor release are located near a building;
- Where a significant preferential pathway exists that connects a VOC source with a nearby building;
- Where NAPL is located near a building;
- Where VOC odors attributable to a release under investigation are detectable inside a structure indicating that the indoor air exposure pathway is likely complete; or
- Where contaminated groundwater has or continues to enter a structure and the VOCs are volatilizing into the indoor air space creating an exposure.

Where the indoor air exposure pathway is complete, indoor air sampling to assess the potential risk to human health is recommended. Where the potential risk is determined to be significant, mitigation efforts should be evaluated and implemented as appropriate including any follow up monitoring. Section 9.0 describes strategies that may be appropriate for mitigating vapor intrusion.

### **3.2 Method 1 Approach**

The Method 1 approach is typically a multiple step process as outlined below. Multiple lines of evidence are used to determine whether the vapor intrusion pathway is complete, and if so, whether there is a significant risk to building occupants. Site data is collected and compared to the appropriate Method 1 screening levels. The screening levels are listed in Table 1 and are further explained in Section 4.0 and are identified as follows:

- Groundwater to indoor air screening levels.
- Soil gas screening levels (residential and commercial).
- Indoor air screening levels (residential and commercial).

The vapor intrusion Method 1 screening value lookup numbers in Table 1 may not be appropriate for all sites, and it may not be necessary to sample all three media (groundwater, soil gas, and indoor air) at all sites to determine if vapor intrusion is a pathway of concern. Each step of the screening process provides additional lines of evidence that the pathway is likely complete, indicating that further

evaluation of the pathway may be necessary or the pathway is incomplete. Figure 2 provides a flow chart on evaluating the vapor intrusion pathway. DES does not have bulk soil sample screening levels for evaluating the vapor intrusion pathway. As a result, where bulk soil sample data indicates a vadose zone source of VOCs, soil gas data and/or indoor air data should be collected to assess the vapor intrusion pathway. When sampling groundwater, soil gas, or indoor air for comparison with the vapor intrusion screening levels, multiple sampling events that cover the expected range of conditions that may influence concentrations, should be conducted (i.e., seasonal, atmospheric, hydrogeologic, etc.).

Typically the first step in the Method 1 approach is comparison of groundwater data collected from the study area to the GW-2 values summarized in Table 1. In general, when evaluating a dissolved phase plume where other potential vapor intrusion factors are not a concern (i.e. NAPL, vadose zone VOC source, contaminated groundwater seeping into a building), if all compounds of concern (COC) in groundwater are less than the respective GW-2 values, the pathway is determined to be incomplete. If a COC in groundwater exceeds the GW-2 value near a structure, further assessment of the pathway should be conducted.

If an exceedance of a GW-2 value has been identified in the study area, the next step in the Method 1 approach would be to conduct an exterior soil gas sampling program to evaluate the soil gas vapor plume. When conducting soil gas sampling to assess the vapor intrusion pathway, DES recommends using the vapor intrusion conceptual site model check list included in Appendix A. Soil gas sampling is further detailed in Section 5.0. Soil gas data collected in the study area would then be compared to the soil gas screening levels in Table 1. If the levels in soil gas are less than the soil gas screening levels, it may be possible to rule out vapor intrusion as a potential pathway. See Section 7.0 for a discussion on evaluating results. If a COC exceeds a soil gas screening value, this provides additional evidence that there is a potential for vapor intrusion to nearby buildings and that further assessment should be conducted.

If an exceedance of a soil gas screening level has been identified during the exterior soil gas sampling program, further assessment will typically involve collection of indoor air samples from structures suspected of being impacted by vapor intrusion.

Indoor air concentrations should be compared to the indoor air screening levels in Table 1. If COC levels in indoor air are less than the indoor air screening levels further evaluation of the vapor intrusion pathway may not be necessary. If an exceedance of an indoor air screening level has been identified, and the pathway is determined to be complete, abatement measures, continued monitoring, or further assessment and/or evaluations may be necessary. Indoor air sampling and related indoor air background issues are discussed in Section 6.0. See Section 7.0 for a discussion on evaluating results.

If the pathway is determined to be complete, or likely complete, at any stage of the investigation a site specific health risk assessment can be completed in lieu of using the screening levels in Table 1. The frame work for conducting a site specific risk assessment for the vapor intrusion pathway is presented in Appendix E.

### 3.3 Site Specific Vapor Intrusion Pathway Assessment

A site specific vapor intrusion pathway assessment addresses a broad range of site conditions and can involve increasingly more sophisticated site-specific data collection, analysis, and data evaluation than the Method 1 approach.

The following vapor intrusion assessment tools may be useful when conducting a site specific vapor intrusion pathway assessment:

- Completing site specific cumulative risk calculations based on site specific exposure factors.
- Obtaining lateral and vertical soil gas profiles to demonstrate attenuation and/or biodegradation.
- Use of additional investigative tools as described in Section 8 including:
  - Determination of a site-specific soil gas attenuation factor using a conservative tracer
  - Indoor/sub-slab differential pressure measurements
  - Passive soil gas sampling
  - Flux chamber sampling
  - Modeling

The site specific vapor intrusion pathway assessment approach and results should be fully documented in a report that includes a conceptual site model of subsurface vapor transport mechanisms and site specific measurements and analysis. DES recommends that a work plan be submitted to the department for comment prior to completing a site specific vapor intrusion pathway assessment.

## 4.0 METHOD 1 VAPOR INTRUSION SCREENING LEVELS

DES has developed threshold screening levels for groundwater, soil gas, and indoor air for use in the Method 1 approach for evaluating the vapor intrusion pathway. Where any of the screening levels are exceeded at a site the vapor intrusion pathway should be evaluated further except where the indoor air levels are attributable to background. The following screening levels are based on a conservative inhalation risk exposure scenario.

### 4.1 Groundwater Screening Levels

As noted above DES recommends that the vapor intrusion pathway be evaluated at sites in New Hampshire where VOCs are detected in groundwater above the GW-2 levels within 100 feet (vertically or horizontally) of an occupied building. For petroleum hydrocarbon sites, the GW-2 levels would apply within 30 feet (vertically or horizontally) of an occupied building.

Where groundwater data exists for a site, the contaminant concentrations should be compared to the GW-2 values in Table 1. The GW-2 screening levels are intended to provide guidance on when it may be appropriate to examine the vapor intrusion pathway from a dissolved phase plume. The GW-2 screening levels will often provide the first step of the Method 1 vapor intrusion pathway assessment as groundwater data is often collected during the initial stages of any site investigation.

When installing groundwater monitoring wells for assessing the vapor intrusion pathway, wells should intersect the water table throughout the year, (i.e., a water table well) and have a water column

thickness of 10 feet or less. Where a clean water lens or a perched water table exists of sufficient thickness, vertical profiling of VOC levels in groundwater may be warranted.

At sites that may have contamination due to a vadose zone source including contaminated soil or vapor leaks, groundwater data may not be an appropriate tool for assessing the vapor intrusion pathway for these sources. Soil gas data would be the more appropriate investigative tool for assessing the risk from vadose zone sources.

## 4.2 Soil Gas Screening Levels

DES has developed two soil gas screening levels, residential and commercial, which are provided in Table 1. The soil gas screening levels in Table 1 may be used where deep exterior soil gas samples are collected adjacent to the structure(s) under investigation and at a depth below the anticipated depth of the foundation, or where sub-slab soil gas samples are collected immediately beneath the building. For residential structures with basements, DES recommends a depth of 10 feet below grade. Soil gas samples collected more than 10 feet horizontally away from a building may not be appropriate for assessing the vapor intrusion pathway. Due to potential variability in soil gas concentrations, multiple soil vapor probes and multiple sampling events that cover the expected range of conditions that may influence concentrations (depth, seasonal, atmospheric, hydrogeologic, etc.) may be necessary to determine if additional investigation of the vapor intrusion pathway may be necessary at a site. Soil gas sampling procedures are outlined in Section 5.0.

Two soil gas screening values have been developed based on different exposure scenarios that account for a residential exposure and for a commercial exposure. The general equation used to calculate the soil gas screening levels is noted below:

$$SG = C_{AIR} / \alpha_{SG}$$

SG = The soil gas screening level in units of  $\mu\text{g}/\text{m}^3$ .

$C_{AIR}$  = Indoor air screening levels for the appropriate exposure scenario, residential or commercial in units of  $\mu\text{g}/\text{m}^3$ .

$\alpha_{SG}$  = Soil gas to indoor air attenuation factor of 0.02, dimensionless.

The soil gas screening values in Table 1 are not intended for use in assessing crawl space vapor samples. Where crawl space vapor samples are collected, the results should be compared with the indoor air screening values listing in Table 1.

## 4.3 Indoor Air Screening Levels

DES has developed two sets of indoor air screening levels for the evaluation of the vapor intrusion pathway. Residential and commercial indoor air screening levels are listed in Table 1. When vapor intrusion is of potential concern, indoor air concentrations may be evaluated using the indoor air screening levels to determine if further evaluation, monitoring or mitigation of the pathway is appropriate. Site-specific background sources should always be considered when interpreting indoor air data. Background contaminant levels, both indoors and from outdoor ambient air, may exceed the Table 1 indoor air screening levels for some compounds. Background determinations should be made on a site-specific basis as part of an overall multiple line of evidence data evaluation.



The indoor air screening levels were derived taking into consideration risk-based criteria, method reporting limits and indoor air background values (residential only). For more information on the risk based criteria and exposure assumptions used to calculate the residential and commercial indoor air screening levels see Appendix E.

For chemicals that have both a carcinogenic and non-carcinogenic value, separate risk-based levels were calculated with the lower (more protective) concentration selected based on the following:

- A concentration equal to 20 percent of a reference concentration (RfC) published by the USEPA or an analogous allowable concentration.
- An indoor air concentration associated with an excess lifetime cancer risk of one-in-one million.

The lower, more protective risk based value was then compared to a background value, if available, and the low level reporting limit for EPA Method TO-15, and the higher number was selected to represent the indoor air screening value listed in Table 1.

## **5.0 SOIL GAS SAMPLING PROCEDURES**

### **5.1 Overview**

The following section provides some basic guidelines for conducting soil gas sampling for assessing the vapor intrusion pathway. Soil gas sampling can be used for a number of purposes including initial site characterization, delineation of a groundwater plume, identification of source areas, evaluation of the vapor intrusion pathway, remediation and post-remediation monitoring. The guidelines outlined below are specific to the evaluation of the vapor intrusion pathway, but may be modified for other corrective action purposes. When soil gas sampling is to be used for assessing the vapor intrusion pathway, DES recommends that work plans be submitted to the department for comment prior to the initiation of fieldwork.

### **5.2 Designing a Soil Gas Sampling Plan**

The development of a soil gas sampling plan, should be site specific, and establish the vapor migration conceptual site model and provide an assessment of the vapor intrusion pathway. DES recommends using the vapor intrusion conceptual site model check list included in Appendix A. General considerations should include the following:

- Identify the objectives of the study.
- Identify the chemicals of concern including parent and breakdown products.
- Identify possible preferential pathways.
- Establish the number, location and analytical method for soil gas samples to satisfy the plan objective including appropriate QA/QC protocols, such as leak testing, sample duplicates, and equipment blanks.
- Establish soil gas probe installation and sampling protocols.
- Determine if vertical profiles are needed to assess potential biodegradation/attenuation.
- Compare the concentrations of the chemicals of concern to the soil gas screening levels.

- Determine if the vapor intrusion pathway is a concern.

### 5.3 Field Screening

As part of any soil gas sampling plan, field screening should be conducted to evaluate potential preferential vapor migration pathways. The field screening survey should evaluate underground utilities such as water, sewer, gas, electric, and telecommunication lines as well as any foundation penetrations, such as sumps, into the structure(s) in the study area. Field screening should be conducted using either a photoionization detector (PID) or flame-ionization detector (FID) or other instrument appropriate for detecting the COC. As most field screening instruments have detection limits in the part per million range, use of these instruments will only provide an indication of gross contamination.

### 5.4 Soil Gas Probes

DES recommends active soil gas sampling for assessing the risk to human health as part of a vapor intrusion assessment and for use in comparison with the soil gas screening levels in Table 1. There are two methods used to collect active soil gas samples, where a vapor sample is collected from the vadose zone and then analyzed either at an off-site laboratory, or on-site in a mobile laboratory; temporary soil gas probes that are only sampled once or, permanent soil gas probes that can be sampled over time to account for expected ranges of conditions that may influence concentrations (i.e., seasonal, atmospheric, hydrogeologic, etc.).

Temporary vapor probes can be installed by making a hole with a slide hammer, then placing a sample probe in the pilot hole and sealing the annular space at the top of the rod with an inert impermeable material. Other temporary vapor probes use a retractable or removable drive tip. After the soil gas sample is collected the probe is removed.

Permanent soil gas probes typically consist of a small-diameter tube with a screen or sample port installed at the tip, or a small diameter well. Tubing/well diameter should be small, usually ranging from 1/4 to 1 inch to limit the amount of purge volume. The tube/well is installed to a specific depth in a bore hole created with a slide hammer, direct-push system or a hollow stem auger. Sand is installed in the annulus around the sampling port/well screen and the remainder of the bore hole is sealed with bentonite. The tubing/well is usually capped at the surface and the bore hole is completed with a well cover at ground surface.

Whether installing a temporary or permanent soil gas probe, a competent surface seal is necessary to prevent ambient air from diluting the soil gas sample. Figure 3 shows several types of soil gas probes and well material, and Figure 4 shows a schematic of a permanent soil gas probe.

The collection of sub-slab soil gas samples from directly beneath a building may provide a better indication of a possible vapor intrusion problem than soil gas samples collected beyond the building foot print; however, this sampling method is more intrusive to the building owner/occupant. When contemplating collection of sub-slab soil gas samples care must be taken not to damage the integrity of the slab. Coring through the slab can create a preferential pathway and therefore a proper seal is important when using this method. Figure 5 shows a schematic of a sub-slab soil gas probe.

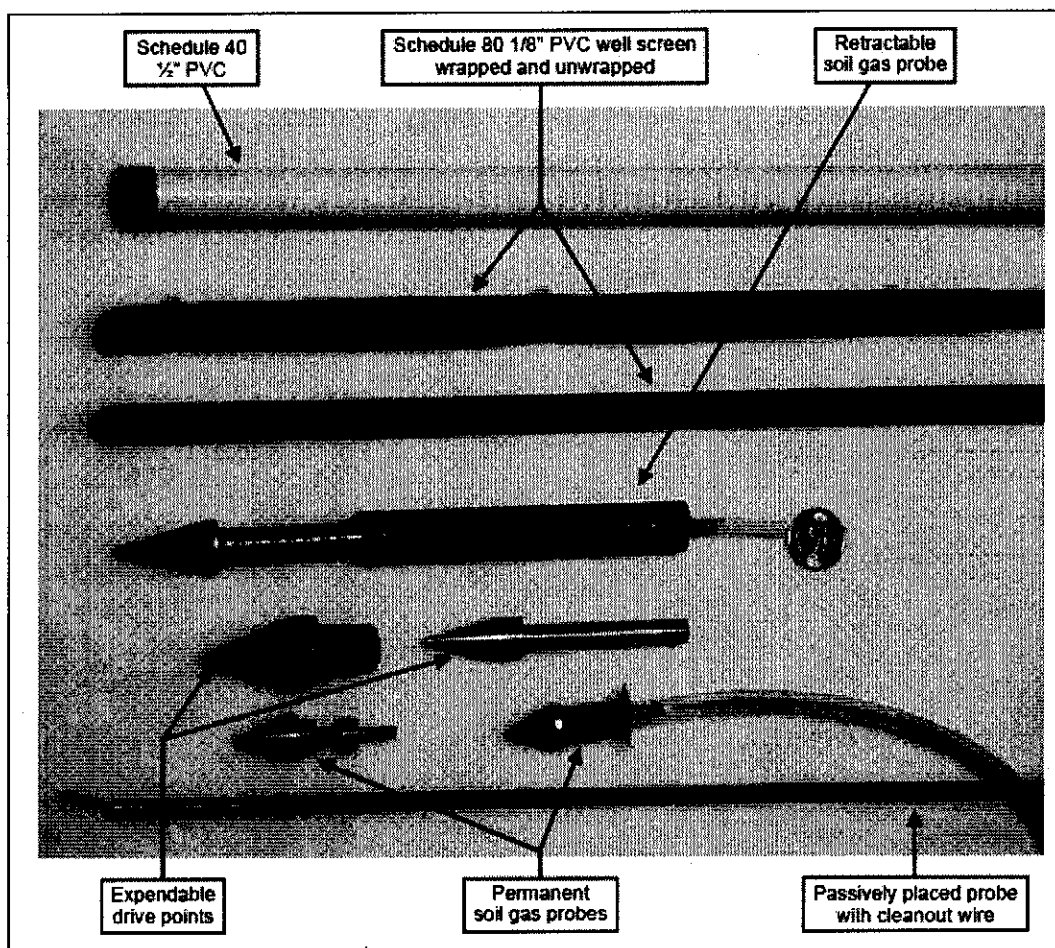


Figure 3 Soil Gas Sampling Probes (NJDEP 2005)

### 5.5 Sample Collection and Analysis

Soil gas samples should be collected at the location(s) suspected of having the highest vadose-zone contamination immediately adjacent (within 10 feet) to the structure(s) under investigation. Samples from the area immediately adjacent to a structure should be collected at a depth well below the base of the foundation. For residential structures with basements, DES recommends a depth of 10 feet below grade. In situations where shallow groundwater prevents this, other sampling procedures may be employed, including collection of sub-slab samples, or exterior soil gas samples from beneath large impervious surfaces where vapor may accumulate such as an adjacent driveway or parking lot. If collecting sub-slab soil gas samples directly beneath a building slab, groundwater should be at least 6 inches below the slab.

When conducting an exterior soil gas sampling program to evaluate vapor intrusion from a large VOC groundwater plume that may impact a significant number of structures, it may not be practical to collect exterior soil gas samples within 10 feet of each structure. For this scenario, the number, depth and location of soil gas samples should be adequate to conservatively delineate the subsurface soil gas plume, and identify structures that may be susceptible to vapor intrusion.

For undeveloped lots where future structures are planned, deep exterior soil gas samples may be used to assess the potential for vapor intrusion for the future use scenario planned. The number and depth of soil gas samples should be adequate to conservatively delineate concentrations in soil gas.

Short-circuiting of atmospheric air into the soil gas probe can result in diluted soil gas samples that under report actual subsurface soil gas concentrations for the COC. To ensure that valid soil gas samples are collected as part of a vapor intrusion assessment the use of a tracer compound can be used to assess for surface/annular seal leaks around the top of the soil gas probe.

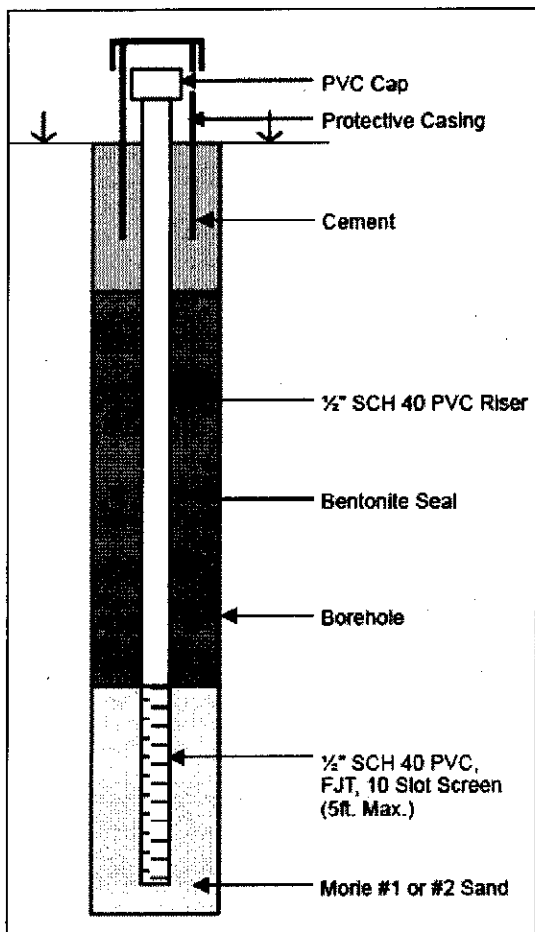


Figure 4 Permanent Soil Gas Probe (NJDEP 2005)

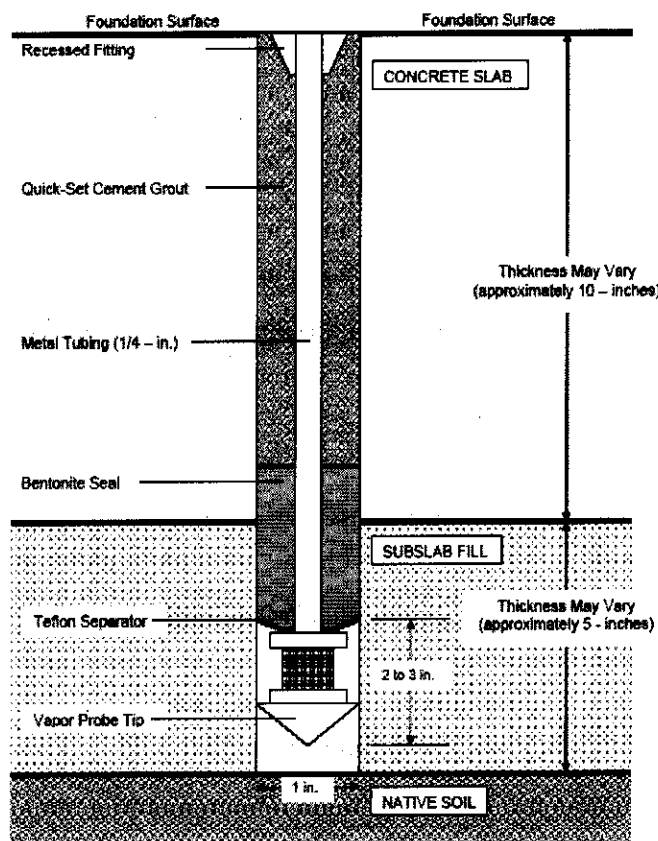


Figure 5 Sub-slab Soil Gas Probe (CAEPA DTSC 2004)

Depending on the nature of the contaminants of concern a number of different compounds can be used as a tracer. Sulfur hexafluoride (SF<sub>6</sub>) or helium are used as tracers because they are readily available have low toxicity and can be monitored with portable measurement devices. Iso-propanol, the main ingredient in rubbing alcohol, could also be used as a tracer but would require laboratory analysis for the tracer. In all cases the same tracer application should be used for all probes at any given site. The leak test should be conducted using a tracer that is not expected to be present in the soil gas being tested.

Because minor leakage around the probe seal should not materially affect the usability of the soil vapor sampling data the presence of low concentrations of the tracer gas in the sample may not be a major cause for concern. If elevated levels of tracer gas are observed in a sample, the soil gas data should not be considered reliable and the probe seal should be modified to reduce the infiltration of ambient air and the probe re-sampled. Portable field monitoring devices with detection limits in the low ppm range should be adequate for screening samples for tracer leak testing.

Potential short circuiting of atmospheric air during sampling can also be indirectly evaluated through examination of oxygen and carbon dioxide data collected from soil gas probes and ambient air. For example if oxygen concentrations at a probe installed within a petroleum hydrocarbon source area are at atmospheric levels the soil gas data should not be considered reliable and the probe seal should be modified and the probe re-sampled. DES recommends collecting oxygen and carbon dioxide data when conducting soil gas surveys to assess the vapor intrusion pathway. DES recommends using the Soil Gas Probe Field Data Report Form in Appendix B when conducting soil gas evaluations.

Prior to collecting the soil gas sample for analysis DES recommends a minimum of one to a maximum of five purge volumes be evacuated from the soil gas probe. The purge volume should be consistent for all samples collected from the study area. When purging or collecting samples using a vacuum pump or a canister the vacuum applied to the soil gas probe should be kept to the minimum necessary to collect the sample and the flow rate should not exceed 200 milliliters per minute. This should limit the potential for ambient air being drawn into the soil gas sample from the ground surface and it should limit desorbing of vapors from contaminated soils. Depending on the scope of the study and the data quality objectives, soil gas samples may be collected using gas-tight syringes, sorbent media, canisters or tedlar bags. Gas tight syringes and tedlar bags are appropriate when an on-site field laboratory is utilized and samples are analyzed immediately following sample collection. The following table provides a list of several soil gas analytical methods.

Method No.	Collection Device Methodology	Type of Compounds	Detection Limit Range
TO-1	Tenax solid sorbent GC/MS or GC/FID	VOC	0.02 – 200 ug/m <sup>3</sup> (0.01-100 ppbv)
TO-2	Molecular sieve sorbent GC/MS	VOC	0.2 – 400 ug/m <sup>3</sup> (0.1-200 ppbv)
TO-3	Cryotrap GC/FID	VOC	0.2 – 400 ug/m <sup>3</sup> (0.1-200 ppbv)
TO-13A	Polyurethane foam GC/MS	PAH	0.5-500 ug/m <sup>3</sup> (0.6 – 600 ppbv)
TO-15	Canister GC/MS	VOC (polar/nonpolar)	0.4 – 20 ug/m <sup>3</sup> (0.2-2.5 ppbv)
TO-17	Single/multi-bed adsorbent GC/MS FID	VOC	0.4 – 20 ug/m <sup>3</sup> (0.2-2.5 ppbv)
8021B	Tedlar Bag Canister GC/PID	VOC	4.0 – 60.0 ug/m <sup>3</sup> (0.3 ppbv to 30 ppbv)
8260B	Tedlar Bag Canister GC/MS	VOC	10.0 – 50.0 ug/m <sup>3</sup> (0.6 ppbv to 25 ppbv)
8270C	Tedlar Bag Canister GC/MS	SVOC	1000 ug/m <sup>3</sup> (20000 ppbv to 100000 ppbv)

To maintain sample integrity:

- Maximum holding times for soil gas samples should not be exceeded.

- Soil gas samples should not be chilled during storage.

Soil gas samples should be analyzed for the appropriate COC including breakdown products as part of the vapor intrusion assessment. The analytical method used should be able to identify and quantify the target analytes and be capable of meeting the soil gas screening levels listed in Table 1. DES recommends that all soil gas analysis be done using gas chromatography. Soil gas sample results submitted to DES should be reported in units of  $\mu\text{g}/\text{m}^3$ . Soil gas sampling field data should be detailed on the Soil Gas Probe Field Data Report Form and submitted with the results.

## **5.6 Soil Gas Data Evaluation**

The evaluation of soil gas data should determine if the pathway is likely complete or if additional data is needed to evaluate the pathway. A data quality evaluation should be completed to determine if the data is sufficient to be used for the pathway assessment, by reviewing tracer results and detection limits to determine data usability.

If the levels in soil gas below or immediately adjacent to a building are above the soil gas screening levels indicating that the indoor air pathway is likely complete future actions may include the following:

- Conduct additional soil gas sampling to develop a more complete understanding of the distribution of chemicals in soil gas.
- Conduct indoor air sampling to correlate soil gas levels to indoor air levels for COC taking in to account indoor air background levels.
- Implement abatement actions.
- Use additional investigative tools as described in Section 8.

If the concentrations of COC in soil gas at or near the building are below the soil gas screening levels and the data quality objectives are satisfactory then the vapor intrusion pathway may not be a concern; however, due to potential variability in soil gas concentrations, multiple soil vapor probes and multiple sampling events that cover the expected range of conditions that may influence concentrations (depth, seasonal, atmospheric, hydrogeologic, etc.) may be necessary.

## **6.0 INDOOR AIR SAMPLING**

### **6.1 General Approach**

There are inherent problems with sampling indoor air and also with interpreting the results. Indoor air sampling should be conducted after groundwater and/or soil gas data indicate the potential for vapor intrusion. Indoor air sampling may also be necessary under other circumstances including contaminated groundwater intrusion into buildings, before, during or after corrective actions have been taken, where preferential pathways exist that would limit the usefulness of groundwater or soil gas data, at residential fuel oil spill sites or where there are odor complaints.

When conducting indoor air sampling as part of a vapor intrusion pathway assessment there are several steps that should be taken into account.

- Define the study goals.
- Identify the COC including parent and breakdown products.
- Select number and location of sampling locations.
- Select duration of sampling event.
- Select sampling method with appropriate detection limit.
- Establish QA/QC requirements.

When contemplating indoor air sampling to assess large plumes that have the potential to impact a significant number of structures, DES recommends identifying primary and secondary structures for indoor air sampling. Conduct indoor air sampling at the primary structures first based on groundwater and exterior soil gas concentrations. Expand the scope of indoor air sampling to the secondary structures if some of the primary structures show vapor intrusion impacts. This investigative strategy, or “step-out process,” should be conducted in a sequential manner until a perimeter of no impacts is defined.

## **6.2 Site Inspection, Product Inventory and Field Screening**

Prior to collecting indoor air samples a site inspection should be conducted and a building inventory of potential VOC sources should be completed. Field screening of potential preferential pathways into the structure should also be conducted. The field screening survey should evaluate any foundation penetrations such as water, sewer, gas, electric and telecommunication lines, as well as sumps. In addition, field screening of potential VOC building sources should be conducted to determine if any products may be leaking VOC vapors into the building. Field screening should be conducted using either an FID or PID appropriate for detecting the COC.

## **6.3 Sample Collection and Analysis**

When collecting indoor air samples, it is advisable to sample under conditions that are the most likely to represent conservative or worst case conditions (refer to Section 6.5). Samples should be collected from the lowest level of the structure where vapors are expected to enter (typically the basement or crawl space), a common area living space/work space on the first floor, and an outdoor location representative of background outdoor ambient air. DES recommends that indoor air samples be collected concurrent with soil gas samples, where appropriate, for a better understanding of the vapor conceptual model at a site.

DES recommends the collection of time integrated indoor air samples for risk assessment purposes as part of the vapor intrusion pathway assessment. The sample duration should be reflective of the site specific exposure scenario that represents the true time-integrated average concentration that an inhabitant may be exposed to. If evaluating low concentration long term exposure for a residential scenario, a 24-hour sample duration should provide a representative sample. For non residential sampling, such as a work place scenario, an 8-hour sampling duration may be more appropriate. Ideally the duration and frequency of sampling should cover the range of conditions that may influence concentrations (i.e., seasonal, atmospheric, hydrogeologic, etc.). For collection of time integrated samples for VOC analysis used for risk assessment purposes DES recommends the use of pre-evacuated stainless steel canisters.

The indoor air samples should be analyzed for the appropriate COC including breakdown products as part of the vapor intrusion assessment. The analytical method should be able to identify and quantify the target analytes and be capable of meeting the indoor air screening levels in Table 1. Laboratories performing low level air analysis should be able to demonstrate the ability to deliver acceptable results. DES recommends that laboratory analysis for VOCs be done using gas chromatography/mass spectrometry (GC/MS) and where appropriate using the high resolution selected ion monitoring (SIM) mode for low level detection. When conducting indoor air sampling the Indoor Air Sampling Form in Appendix C should be completed and sampling should be conducted in accordance with the Indoor Air Sampling Protocol in Appendix D. All indoor air sample results submitted to DES should be reported in units of  $\mu\text{g}/\text{m}^3$ . The following table provides a list of several indoor air analytical methods. For VOC analysis DES recommends EPA Method TO-15 including SIM mode where appropriate.

Method Reference	Description	Types of Target Compounds	Detection Limit Range
TO-4A	High Volume sampling PUF media GC/ECD analysis	Pesticides & PCBs	Pesticides: 0.5 – 1 $\mu\text{g}/\text{sample}$ PCBs: 1 – 2 $\mu\text{g}/\text{sample}$
TO-10A	Low Volume sampling PUF media GC/ECD analysis	Pesticides & PCBs	Pesticides: 0.5 – 1 $\mu\text{g}/\text{sample}$ PCBs: 1 – 2 $\mu\text{g}/\text{sample}$
TO-13A	High Volume sampling PUF/XAD media GC/MS analysis	SVOCs	5 – 10 $\mu\text{g}/\text{sample}$
TO-15LL	Canister collection GC/MS analysis	Non-Polar & Polar VOCs	0.5 – 3 $\mu\text{g}/\text{m}^3$
TO-15 SIM	Canister collection GC/MS (SIM mode) analysis	Low level VOCs	0.011 – 0.5 $\mu\text{g}/\text{m}^3$

TCE is a primary contaminant at many sites in NH and the toxicity of TCE is the subject of considerable debate. In 1989 EPA withdrew the TCE cancer toxicity values from its Integrated Risk Information System (IRIS) database. Since that time, EPA has come out with draft health information that TCE is suspected of being more toxic than previously thought. Due to the uncertainty associated with the toxicity of this chemical DES recommends that when conducting indoor air sampling for the vapor intrusion pathway where TCE is a COC, analysis be completed using selected ion monitoring (SIM) when appropriate, to achieve the lowest detection limit possible to determine if TCE is present in indoor air.

## 6.4 Background

There are two types of background associated with indoor air sampling, indoor air background and ambient outdoor background. Either may exceed the indoor air screening levels listed in Table 1. Although there is a simple way to measure ambient outdoor background it is difficult to reliably measure indoor air background. For these reasons collection of indoor air data without additional lines of evidence to indicate the potential for vapor intrusion from subsurface sources is not advised. Where vapor intrusion COC are expected to be present as background sources in a building, DES recommends collecting sub-slab soil gas samples concurrent with the collection of indoor air samples.



There have been several studies that have measured indoor air and ambient outdoor air background levels. The New York State Department of Health collected samples from 104 single family homes heated with fuel oil between 1997 and 2003. More than 600 samples were collected from basements, living spaces and outdoor ambient air. The US EPA Building Assessment and Survey Evaluation (BASE) study was conducted on 100 public and commercial office buildings between 1994 and 1998. The 25<sup>th</sup> to 75<sup>th</sup> percentile range of concentrations from these two studies have been summarized in the Table below for some of the more common VOCs detected in groundwater at contaminated sites. Units are in  $\mu\text{g}/\text{m}^3$ .

Compound	NYSDOH Study (1997-2003)		EPA BASE Data (1994-1998)	
	Residential Single Family Homes		Commercial Office Buildings	
	Indoor	Outdoor	Indoor	Outdoor
Trichloroethane, 1,1,1-	<0.25 – 1.1	<0.25 – 0.38	2.6 – 11	<0.6 – 1.7
Dichloroethane, 1,2-	<0.25	<0.25	<0.6	<0.6
Trimethylbenzene, 1,2,4-	0.69 – 4.3	<0.25 – 0.81	1.7 – 5.1	<1.6 – 3.1
Trimethylbenzene, 1,3,5-	<0.27 – 1.7	<0.25 – 0.34	<1.5	<1.4
Benzene	1.1 – 5.9	0.57 – 2.3	2.1 – 5.1	1.2 – 3.7
Ethylbenzene	0.41 – 2.8	<0.25 – 0.48	<1.6 – 3.4	<1.4 – 1.6
Methylene chloride	0.31 – 6.6	<0.25 – 0.73	<1.7 – 5.0	<1.8 – 3.0
Xylenes (m&p)	0.50 – 4.6	<0.25 – 0.48	4.1 – 12	<3.6 – 7.3
Methyl-tert-butyl-ether	<0.25 – 5.6	<0.25 – 0.86	<1.7 – 12	<1.8
Tetrachloroethylene	<0.25 – 1.1	<0.25 – 0.34	<1.9 – 5.9	<1.4 – 3.0
Toluene	3.5 – 24.8	0.61 – 2.4	10.7 – 26	5.9 – 16
Trichloroethylene	<0.25	<0.25	<1.2 – 1.2	<1.5
Vinyl chloride	<0.25	<0.25	<0.9	<1.0

To minimize the impact of indoor air background for residential sampling, indoor activities such as smoking, use of sprays, solvents, paints, etc., should be suspended immediately prior to and during sampling. Outdoor activities that could influence indoor air levels such as mowing, painting, and asphaltting, should also be suspended during sampling.

## 6.5 Sampling under Conservative Conditions

Sampling under conservative conditions is a matter of where and when the samples are collected. Conservative samples are generally located in the basement or lowest portion of the building (crawl space) where vapors first enter a structure. Conservative samples would also be defined under certain ambient conditions as noted below.

Parameter	Most conservative	Least conservative
Season	Late winter/early spring	Summer
Temperature	Indoors 10°F greater than outdoors	Indoor temp. less than outdoor
Wind	Steady greater than 5 mph	Calm
Soil	Saturated with rain	Dry
Doors/Windows	Closed	Open
Mechanical Heating System	Operating	Off
Mechanical fans	Off	On

Modified from Massachusetts Indoor Air Sampling and Evaluation Guide (2002)

## **6.6 OSHA Considerations**

The Occupational Safety and Health Act of 1970 (OSHA) uses permissible exposure limits (PELs) to regulate work place exposure to chemicals. OSHA PELs are based not only on risk but are adjusted to account for factors including economic feasibility. PELs are different than the DES indoor air screening levels, which have been established for chemicals that are released to the environment and are generally based on risk exposure criteria. For most of the identified VOCs in Table 1 the DES indoor air screening levels are well below the established OSHA PELs.

The following examples illustrate where OSHA PELs would apply or where the use of this guidance would be more appropriate to evaluate exposures due to vapor intrusion at contaminated sites.

- If an industrial worker is exposed to vapors from a subsurface source of contamination regulated by DES (regardless of whether that contamination is derived from that facility or another) and are simultaneously exposed to the same hazardous vapors in the work place and is knowledgeable of their exposures then the exposure would be regulated under OSHA.
- If an industrial worker is exposed to vapors from subsurface contamination and exposed to different hazardous chemicals in the work place that they protect themselves against but not those associated with the subsurface contamination then the exposure associated with the release may be managed in accordance with this guidance. The employer has the option of incorporating the additional environmental exposure into their employee protection program in which case OSHA requirements would apply.
- If a worker is exposed to vapors from subsurface contamination that is not associated with the normal operating conditions of that work place, such as a commercial office building, restaurant or daycare center, then the employee's exposure may be managed in accordance with this guidance.

In general, DES recommends using this guidance where employees within buildings have not voluntarily accepted a risk associated with environmental contamination in connection with their employment. This can include buildings located at the spill site, and properties down gradient of the spill site.

## **7.0 EVALUATION OF RESULTS**

When conducting a vapor intrusion investigation, the goals are to determine if vapor intrusion is occurring, and if so is mitigation necessary to protect building occupants. Once all the analytical results have been collected the data should be compared to the appropriate screening levels. DES recommends a multiple line of evidence approach when evaluating the vapor intrusion pathway.

Groundwater data should be evaluated to determine if the extent of the VOC plume has been adequately delineated. Groundwater data should be compared with the GW-2 groundwater screening values, and all buildings within 100 feet horizontally (30 feet for petroleum hydrocarbons) of groundwater that exceeds the screening levels should be identified for further evaluation.

Once groundwater data indicates the potential for vapor intrusion an exterior soil gas sampling program should be conducted to delineate the extent of the subsurface vapor plume. The results of exterior soil gas sampling should then be compared with the appropriate soil gas screening levels. Where soil gas samples do not exceed the screening levels, but groundwater exceeds the screening levels, a site specific evaluation is recommended to determine if vapor intrusion may be ruled out. This evaluation would require an understanding of the site conceptual model and should take into consideration the following:

- Shallow groundwater concentrations will not likely increase in the future.
- Site conditions at the time of soil gas sampling are not likely to result in higher soil gas concentrations due to seasonal, atmospheric, hydrogeologic, or other reasons.

Due to the potential for variability in soil gas concentrations, DES does not recommend the averaging of soil gas samples. Each data point should be evaluated separately. Where groundwater exceeds the GW-2 screening levels, DES recommends that a minimum of two rounds of exterior soil gas data be collected to rule out vapor intrusion as a potential exposure pathway due to potential variability in soil gas concentrations. If exterior soil gas samples exceed the screening values then additional investigation of the vapor intrusion pathway may consist of collecting indoor air samples from structures that may be at risk of vapor intrusion.

Determining if there is an exceedance of the indoor air screening levels attributable to vapor intrusion can be difficult. When reviewing indoor air data as part of a vapor intrusion pathway assessment it is important to distinguish between background VOCs in indoor air from VOCs determined to be the result of vapor intrusion. A few examples are illustrated below:

- Compare the relative concentration of COC at different locations in a structure;

If the ratio of benzene to xylene in the basement is 1:1 and there is three times as much xylene as benzene on the first floor there is probably a background source of xylene located on the first floor.

- Evaluate concentration gradients of contaminants of concern within a structure.

If the concentration of a contaminant is highest in the basement and decreases as you move up to the first and second floors vapor intrusion may be the primary source. If the concentrations are higher in the upper floors than the basement a background source unrelated to vapor intrusion is probably located in the structure and may be the primary source.

- Compare sub-slab soil gas data to indoor air data.

Contaminants detected in indoor air that are not detected in sub-slab samples indicates there is likely a background source unrelated to vapor intrusion. If a concentration gradient exists where sub-slab concentrations are higher than indoor air concentrations of COC this is an indication that vapor intrusion is occurring that may warrant further evaluation, abatement or continued monitoring.

As illustrated above when developing the conceptual vapor migration model for a site and determining contributions from background, sub-slab soil gas data combined with indoor air data can be helpful particularly when COC are likely to be present from background sources not related to vapor intrusion. In some instances it may be more economical to mitigate an anticipated vapor intrusion exposure than to conduct rigorous indoor air testing.

If indoor air sampling indicates there is no exceedance of the indoor air screening levels then further evaluation of the pathway may not be necessary, however, multiple sampling events may be necessary to rule out vapor intrusion as a pathway of concern.

If the levels in indoor air exceed the indoor air screening levels as a result of vapor intrusion, abatement measures and/or continued monitoring or further assessment may be warranted.

Further assessment may consist of a site specific health risk assessment. A site specific health risk assessment should demonstrate that the contribution of VOCs from vapor intrusion is not presenting a significant risk to building occupants. The frame work for conducting a site specific health risk assessment for the vapor intrusion pathway is presented in Appendix E.

## **8.0 ADDITIONAL INVESTIGATIVE TOOLS**

There are a number of different tools available to evaluate VOC vapor migration as part of a site specific vapor intrusion assessment or simply to aide in the understanding of the vapor conceptual site model.

### **8.1 Determination of a Site-specific Soil Gas Attenuation Factor**

Measurement of a conservative tracer inside of a structure and in the sub-slab soil gas below a structure can be used to determine a site-specific soil gas attenuation factor. The calculated site-specific soil gas attenuation factor may then be used to estimate the indoor air concentration of the COC from a measured sub-slab soil gas concentration. This method assumes that all sub-slab vapor phase contaminants are entering the building at equal rates. Naturally occurring radon is a commonly used conservative tracer. If sub-slab samples are being collected concurrent collection of radon may be useful especially if the potential exists for indoor air background levels of the COC.

### **8.2 Indoor/sub-slab Differential Pressure Measurements**

Measurement of the pressure gradient between the sub-slab and overlying structure can assist in interpreting the direction of vapor transport, whether into or out of the structure. If the building is over-pressured relative to the sub-slab, measured indoor concentrations might be more likely attributed to above-ground sources from within the building. Conversely if the building is under-pressured relative to the sub-slab, measured indoor concentrations might be more likely attributed to below-ground sources associated with vapor intrusion. Differential pressure measurements are easy and inexpensive, and can be collected continuously around the clock. The success of this approach may require multiple indoor air measurements to establish long term patterns.

### **8.3 Passive Soil Gas**

DES considers passive soil gas sampling as a qualitative tool. Sampling devices which house an adsorbent material are placed in the subsurface and left to collect vapors over several days. VOCs migrating through the subsurface are collected onto the adsorbent material. The sampling devices are then retrieved and analyzed. Passive soil gas sampling can be an effective tool in understanding the composition and the location of subsurface vapor plumes. DES does not recommend using passive soil gas samples for quantifying contaminant concentrations in soil gas and therefore should not be used for comparison with the soil gas screening levels listed in Table 1.

Passive soil gas sampling methods can be used to collect soil gas from low-permeability and high moisture settings where conventional active soil gas sampling may be problematic. Passive soil gas sampling methods are capable of detecting compounds present in very low concentrations. Passive soil gas samplers can be placed into potential preferential vapor migration pathways such as utility corridors and foundation cracks to determine if these pathways are acting as significant VOC migration pathways into a structure.

### **8.4 Flux Chamber**

Flux chambers are enclosures that are placed directly on a surface for a few hours to a few days, and the resulting contaminant concentration in the enclosure is then measured which yields the contaminant flux at a surface.

Flux chambers are a qualitative tool that can be used to locate surface fluxes of VOC contamination and entry points into structures. Flux chambers may be suitable for structures with dirt floors, larger slabs in good condition, and for future use scenarios on undeveloped land. Specialized equipment and experienced staff is necessary when conducting flux chamber evaluations.

### **8.5 Modeling**

Modeling can assist in evaluating the potential for vapor intrusion from subsurface contamination. One of the most common vapor intrusion models is the Johnson and Ettinger (J/E) model used by EPA. The J/E vapor transport model was originally developed by P. Johnson and R. Ettinger in 1991 and has subsequently been modified by EPA. The J/E model is based on the basic principles of contaminant fate and transport, contaminant partitioning between media and the physical and chemical properties of the contaminants. The model incorporates both diffusion and advection as mechanisms of transport of subsurface vapor into the indoor air environment. The J/E model is based on the following assumptions:

- Steady-state conditions.
- Infinite source of contamination.
- Homogeneous subsurface.
- Uniform air mixing in the structure.
- No preferential pathways.
- No biodegradation.
- Homogeneous distribution of contaminants.

- Contaminant vapors enter structure through cracks in the foundation and walls.
- Structures are slab-on-grade or have basements.
- Ventilation rates and pressure differences are assumed to remain constant.

Using a range of potential input parameters the model can predict a wide range of indoor air impacts spanning orders of magnitude. When using the J/E model, input parameters for a given site should match site-specific conditions. It is important to understand the sensitivity of the input parameters on the results of the model and therefore DES recommends that vapor intrusion evaluations that involve modeling include a sensitivity analysis.

## 9.0 VAPOR INTRUSION ABATEMENT STRATEGIES

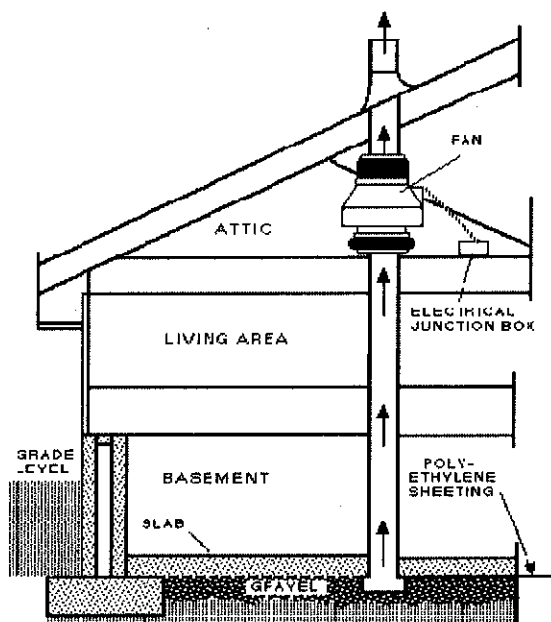
When evaluation of the vapor intrusion pathway shows that vapor intrusion is a concern, abatement strategies can eliminate or mitigate the potential exposure pathway. Strategies for abating vapor intrusion involve both passive and active techniques. A combination of strategies may be most effective. Techniques can include the following:

- Sealing of cracks, utility conduits, sumps etc. in the basement, or crawl space.
- Passive Barriers, i.e. thin plastic liners, heavy HDPE liners, spray on elastomers, etc.
- Sub slab depressurization (SSD), or radon system.
- Natural ventilation.
- Heating recovery ventilation.
- Building pressurization.
- Soil pressurization.
- Indoor air treatment.

If passive techniques are insufficient to limit risk a more active technique may be necessary to prevent the entry of contaminant vapors into a building.

The most common technique for eliminating the vapor intrusion pathway for a residential structure is the installation of a SSD system. This technique has been used for many years to eliminate radon vapor issues. The system works by depressurizing the soil beneath the building envelope thus creating a negative pressure zone that becomes a “sink” for the contaminated vapors. The contaminated vapors are collected and discharged to ambient air typically above the building’s roof line. SSD systems can be used in buildings with a basement, crawl space or slab-on-grade foundation. If the floor of the basement or crawl space is dirt, a membrane/vapor barrier must be placed and sealed to the foundation wall as part of the overall system. Figure 5 shows a schematic of a residential SSD system. SSD systems have been successful in reducing the health risks associated with vapor intrusion for building occupants.

The components of a typical residential SSD system include: an extraction pit beneath the slab or membrane, PVC piping and a blower. A couple of important considerations prior to installation of the SSD system are that groundwater should be more than 6 inches below the foundation and that all entry points such as cracks in the foundation floor and walls and sumps must be sealed.



**Figure 6 Sub slab Soil Depressurization System (EPA April 2001)**

When designing an SSD system there are other considerations. A visible or audible alarm may be desirable to indicate when a loss of system pressure has occurred. The possibility of back drafting occurring in the system should also be considered. This is especially important in buildings with heating systems that vent combustion gases to the ambient air.

DES recommends that SSD systems be designed and installed by professionals with prior experience with these type of radon systems and preferably are certified by either the National Environmental Health Association or the National Radon Safety Board. All designs should have site specific performance standards along with a plan to monitor these standards.

For proposed buildings that are to be constructed over a VOC source that has the potential to cause vapor intrusion, DES recommends at a minimum that a passive venting system be installed, that can be modified to an active system at a later date if necessary.

## 10.0 REFERENCES

American Petroleum Institute. October 2004. "Collecting and Interpreting Soil Gas from the Vadose Zone: A Practical Strategy for Assessing the Subsurface-Vapor-to-Indoor-Air Migration Pathway at Petroleum Hydrocarbon Sites." Final Draft.

California Environmental Protection Agency Department of Toxic Substance Control. (CAEPA DTSC) December 15 2004. "Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air."

Colorado Department of Public Health and Environment. Hazardous Materials and Waste Management Division September 2004. "Indoor Air Guidance."

DeVaul G.E. R.A. Ettinger J.P. Salanitro and J.B. Gustafson. 1997. Benzene toluene ethylbenzene and xylenes [BTEX] degradation in vadose zone soils during vapor transport: First-order rate constants. Proceedings of the petroleum hydrocarbons and organic chemicals in groundwater conference: Prevention detection and remediation. November 12-14 1997 Houston TX. Ground Water Publishing Company Westerville Ohio 365-379.

Fitzpatrick Nancy A and John J. Fitzgerald. October 1996. "An Evaluation of Vapor Intrusion into Buildings through a Study of Field Data." Massachusetts Department of Environmental Protection

Folkes D.J. "Design Effectiveness and Reliability of Sub-Slab Depressurization Systems for Mitigation of Chlorinated Solvent Vapor Intrusion." Presented at USEPA Seminars on Indoor Air Vapor Intrusion. December 2002. January 2003. February 2003. USEPA Office of Research and Development.

Hartman Blayne. October 2002. "How to Collect Reliable Soil-Gas Data for Risk-Based Applications Part 1: Active Soil-Gas Method." LUSTLine Bulletin 42.

Hartman Blayne. November 2004. "How to Collect Reliable Soil-Gas Data for Risk-Based Applications Part 3: Answers to Frequently Asked Questions." LUSTLine Bulletin 48.

Interstate Technology Regulatory Council Brownfields Team. December 2003. "Vapor Intrusion Issues at Brownfield Sites."

Johnson P.C. May 2002. "Identification of Critical Parameters for the Johnson and Ettinger (1991) Vapor Intrusion Model." American Petroleum Institute Technical Report.

Massachusetts Department of Environmental Protection. December 1995. "Guidelines for the Design Installation and Operation of Sub-Slab Depressurization Systems." Northeast Regional Office.

Massachusetts Department of Environmental Protection (MADEP). April 2002. "Indoor Air Sampling and Evaluation Guide." Office of Research and Standards.

New Jersey Department of Environmental Protection (NJDEP). August 2005. "Field Sampling Procedures Manual."



New York State Department of Health. 1997-2003. "Study of Volatile Organic Chemicals in Air of Fuel Oil Heated Homes" revised November 14, 2005.

Roggemans S. C.L. Bruce and P.C. Johnson. December 2001. "Vadose Zone Natural Attenuation of Hydrocarbon Vapors: An Empirical Assessment of Soil Gas Vertical Profile Data." American Petroleum Institute Technical Report.

United States Environmental Protection Agency (USEPA) 2001. Building Assessment and Survey Evaluation (BASE) Database. Washington DC: Office of Air and Radiation.

USEPA. April 2001. "Building Radon Out – A step by step Guide on How to Build Radon Resistant Homes." EPA 402-K-01-002.

USEPA January 1999. "Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air Second Edition." EPA/625/R-96/010b.

USEPA October 1993. "Radon Mitigation Standards," EPA 402-R-93-078. Revised April 1994.

USEPA. October 1993. "Radon Reduction Techniques for Existing Detached Houses: Technical Guidance for Active Soil Depressurization Systems 3<sup>rd</sup> Edition." EPA/625/R-93/011.

USEPA 2002. "OSWER Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)." Draft

USEPA. "Standard Operating Procedure (SOP) for Installation of Sub-Slab Vapor Probes and Sampling Using EPA Method TO-15 to Support Vapor Intrusion Investigations." Draft.  
Dominic DiGiulio Ph.D. Office of Research and Development. National Risk Management Research Laboratory. Ground-Water and Ecosystem Restoration Division Ada Oklahoma.

**New Hampshire Department of Environmental Services  
Waste Management Division Site Remediation Programs**

**Table 1  
Vapor Intrusion Screening Levels**

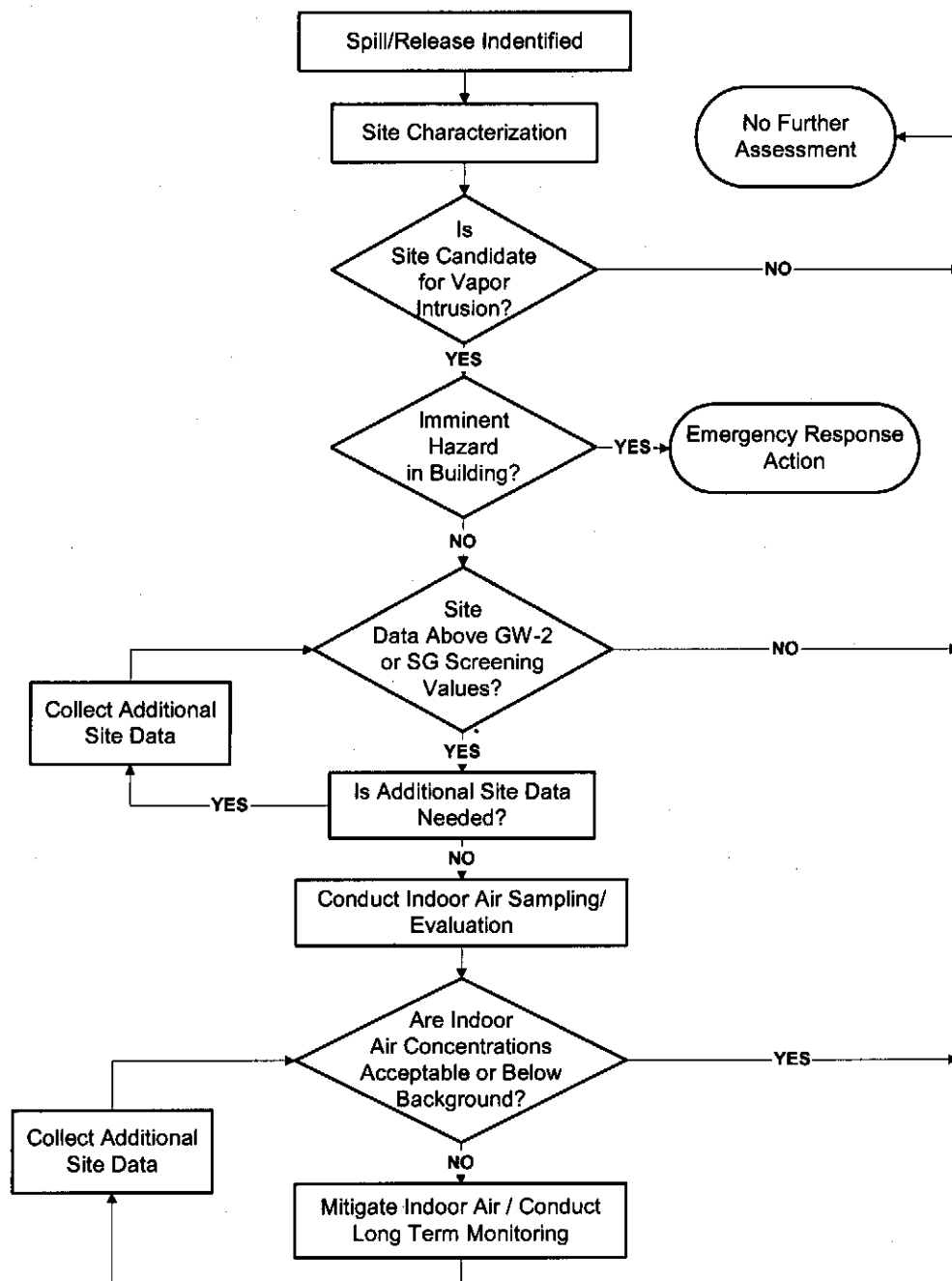
Chemical	Residential Indoor Air Screening Levels ( $\mu\text{g}/\text{m}^3$ )	Commercial Indoor Air Screening Levels ( $\mu\text{g}/\text{m}^3$ )	Residential Soil Gas Screening Levels ( $\mu\text{g}/\text{m}^3$ )	Commercial Soil Gas Screening Levels ( $\mu\text{g}/\text{m}^3$ )	Groundwater to Indoor Air Screening Levels GW-2(1) ( $\mu\text{g}/\text{L}$ )
Benzene	1.9 <sup>(2)</sup>	1.9 <sup>(2)</sup>	95	95	2,000
Bromoform	2.4	11	120	550	2,000
Bromomethane	1.0	1.5	50	73	10
Carbon Tetrachloride	1.3 <sup>(3)</sup>	1.3 <sup>(3)</sup>	63	63	40
Chlorobenzene	12	18	600	880	3,000
Chloroform	1.0 <sup>(3)</sup>	1.0 <sup>(3)</sup>	49	49	200
Dichlorobenzene, 1,2-	40	58	2000	2900	20,000
Dichlorobenzene, 1,4-	160	230	8000	12000	50,000
Dichloroethane, 1,1-	100	150	5000	7300	10,000
Dichloroethane, 1,2-	0.8 <sup>(3)</sup>	0.8 <sup>(3)</sup>	40	40	300
Dichloroethylene, 1,1-	40	58	2000	2900	1,000
Dichloromethane (Methylene Chloride)	5.6 <sup>(2)</sup>	26	280	1300	1,000
Dichloropropane, 1,2-	0.9 <sup>(3)</sup>	1.2	46	59	200
Ethylbenzene	200	290	10000	15000	50,000
Ethylene dibromide	1.5 <sup>(3)</sup>	1.5 <sup>(3)</sup>	77	77	700
Methyl ethyl ketone	1000	1500	50000	73000	50,000
Methyl isobutyl ketone	600	880	30000	44000	50,000
Methyl tert butyl ether (MTBE)	5.6 <sup>(2)</sup>	15	280	770	10,000
Naphthalene	2.6 <sup>(3)</sup>	2.6 <sup>(3)</sup>	130	130	2,000
Styrene	200	290	10000	15000	50,000
Tetrachloroethane, 1,1,2,2-	1.4 <sup>(3)</sup>	1.4 <sup>(3)</sup>	69	69	1,000
Tetrachloroethylene (PCE)	1.4 <sup>(3)</sup>	2.1	68	100	80
Toluene	1000	1500	50000	73000	50,000
Trichlorobenzene, 1,2,4-	3.7 <sup>(3)</sup>	3.7 <sup>(3)</sup>	190	190	1,000
Trichloroethane, 1,1,1-	440	640	22000	32000	20,000
Trichloroethane, 1,1,2-	1.1 <sup>(3)</sup>	1.1 <sup>(3)</sup>	55	55	500
Trichloroethylene (TCE)	1.1 <sup>(3)</sup>	1.1 <sup>(3)</sup>	54	54	50
Trimethylbenzene, 1,2,4-	4.3 <sup>(2)</sup>	4.3 <sup>(2)</sup>	220	220	3,000
Trimethylbenzene, 1,3,5-	1.7 <sup>(2)</sup>	1.8	85	88	1,000
Vinyl chloride	0.5 <sup>(3)</sup>	2.8	26	140	10
Xylenes (mixed isomers)	20	29	1000	1500	30,000

(1) Revised Risk Characterization and Management Policy GW-2 values.

(2) The screening values for these compounds are based on published background values.

(3) The risk based levels for these compounds are below the EPA TO-15 low level reporting limit and therefore the screening value is based on method reporting limit.

**Figure 2 - Evaluating the Vapor Intrusion Pathway**



**APPENDIX A**  
**New Hampshire Department of Environmental Services**  
**Waste Management Division**  
**Site Remediation Programs**

**Vapor Intrusion Conceptual Site Model Checklist**

To assist in the development of the vapor intrusion conceptual site model and for planning soil gas sampling programs for SRI, the following information should be completed:

**Utilities and Process Piping**

- ☐ Identify on a site plan all underground utilities near the soil or groundwater impacts; pay particular attention to utilities that connect impacted areas to occupied buildings.
- ☐ Identify on a site plan all underground process piping near the soil or groundwater impacts.

**Buildings**

- ☐ Identify on a site plan all existing and planned future buildings under investigation.
- ☐ Identify the occupancy and use of each building (e.g., residential, commercial)
- ☐ Describe building construction materials (e.g., wood frame, block, etc.), openings (e.g., windows, doors), and height (e.g., one-story, two-story, multiple-story); identify if there is an elevator shaft in the building.
- ☐ Describe building foundation construction including:
  - Type (e.g., basement, crawl space, slab on grade)
  - Floor construction (e.g., concrete, dirt)
  - Depth below grade.
- ☐ Describe the building HVAC system including:
  - Furnace/air conditioning type (e.g., forced air, radiant)
  - Furnace/air conditioning location (e.g., basement, crawl space, utility closet, attic, roof)
  - Source of return air (e.g., inside air, outside air, combination)
  - System design considerations relating to indoor air pressure (e.g., positive pressure is often the case for commercial buildings).
- ☐ Identify sub-slab ventilation systems or moisture barriers present on existing buildings.

**Source Area**

- ☐ Identify the COC's related to the vapor intrusion pathway.
- ☐ Describe the distribution and composition of any NAPL at the site.
- ☐ Identify on a site plan all source areas for the COC's related to the vapor intrusion pathway.
- ☐ Identify on a site plan soil and groundwater results for the COC, between the source area and the

buildings under investigation.

- ☐ Identify on a geologic cross section soil and groundwater results including depth.
- ☐ Describe the potential migration characteristics (e.g., stable, increasing, decreasing) for the distribution of COC.

### **Geology/Hydrogeology**

- ☐ Review all boring logs and soil sampling data to understand the locations of:
  - Sources: NAPL, soil, groundwater, suspected vapor leaks.
  - Soil types:
    - o Finer-grained soil layers
    - o Higher-permeability layers that may facilitate vapor migration.
- ☐ Identify on a geologic cross section distinct strata (soil type and moisture content – e.g., “moist,” “wet,” “dry”) and the depth intervals between the vapor source and ground surface, and include the depth to groundwater.
- ☐ Describe groundwater characteristics (e.g., seasonal fluctuation, hydraulic gradient).

### **Site Characteristics**

- ☐ Estimate the distance from GW-2 groundwater concentration contour interval for each COC to buildings under investigation.
- ☐ Estimate the distance from vadose zone source area to buildings under investigation.
- ☐ Describe the surface cover between the vapor source and buildings under investigation.

[illegible]

29

**APPENDIX C**  
**New Hampshire Department of Environmental Services**  
**Waste Management Division**  
**Site Remediation Programs**

**Indoor Air Sampling Form**

DES Site # \_\_\_\_\_

DES Site Name \_\_\_\_\_

Address \_\_\_\_\_

**Occupant Information**

Name \_\_\_\_\_

Address \_\_\_\_\_

Telephone No (H) ( ) \_\_\_\_\_

(W) ( ) \_\_\_\_\_

Number and Age of Occupant \_\_\_\_\_

Does anyone smoke inside the building? \_\_\_\_\_

**Building Characteristics**

Type of building: (circle) Residential/Industrial/School/Commercial/Multi-use/Other? \_\_\_\_\_

If residential, what type (circle) Single family/Condo/Multi-family/Other? \_\_\_\_\_

If the property is commercial, indicate the business? \_\_\_\_\_

How many floors does the building have? \_\_\_\_\_

Does the building have a (circle) Basement/Crawl space/Slab-on-grade/Other? \_\_\_\_\_

Is the basement used as a living/work space area? \_\_\_\_\_

What type of foundation does the building have (circle) Field stone/Poured concrete/Concrete block /Other? \_\_\_\_\_

Describe the heating system and type of fuel used? \_\_\_\_\_

Is there an attached garage? \_\_\_\_\_

**Spill/Contaminant Source Information**

Type of petroleum/VOC release? \_\_\_\_\_

When did the release occur? \_\_\_\_\_

What areas of the building have been impacted by the release? \_\_\_\_\_

Are there any odors? \_\_\_\_\_ If so describe the odors: \_\_\_\_\_

Where can release odors be detected? \_\_\_\_\_

### Sampling Information

Sampling Date \_\_\_\_\_

Sampler Type Sorbent SUMMA (Please circle one)

Analysis Method TO-4A TO-10A TO-13A TO-15LL TO-15-SIM Other: \_ (Please circle one)

Consulting Firm \_\_\_\_\_

Contact Person \_\_\_\_\_

Telephone No (\_\_\_\_) \_\_\_\_\_

Laboratory \_\_\_\_\_

Telephone No (\_\_\_\_) \_\_\_\_\_

Table 1: Sorbent Tube Sampler Information

Sample ID#	Floor	Room	Tube ID#	Pump ID#	Volume (liters)	Duration (minutes)	Comments

Table 2: Canister Sampler Information

Sample ID#	Floor	Room	Canister ID#	Initial On-site Pressure*	Pressure* On-site Following Sample Collection	Pressure Received at the Laboratory

\* Indicate pressure in units of inches of mercury.

Please provide a sketch of spill area and location of sampler unit(s).

### Pre-Sampling Inspection and Product Inventory

List products or items which may be considered potential sources of VOCs such as paint cans, gasoline cans, gasoline powered equipment, cleaning solvents, furniture polish, moth balls, fuel tank, woodstove, fireplace, etc.

Date and time of pre-sampling inspection \_\_\_\_\_



Table 3: Pre-sampling Inspection Product Inventory

Potential VOC source	Present (Y/N)	Location	Field screening Results (ppm)	Product Condition
Paints or paint thinners				
Gas powered equipment				
Gasoline storage cans				
Cleaning solvents				
Furniture polish				
Moth balls				
Fuel tank				
Wood stove				
Fireplace				
Perfumes/colognes				
Other:				
Other:				
Other:				

Table 4: Potential vapor migration entry point information

Potential Vapor entry points	Present (Y/N)	Field screening results (ppm)	Comments
Foundation penetrations in floor or walls			
Cracks in foundation floor or walls			
Sump			
Floor drain			
Other			
Other			

Was the building aired out prior to sample collection? \_\_\_\_\_

How long was the airing out process? \_\_\_\_\_

Were vapor control methods in effect while the samples were being collected?

Windows open? Yes / No      Ventilation fans? Yes / No      Vapor barriers? Yes / No

Vapor phase carbon treatment system? Yes / No      Other site control measures \_\_\_\_\_

### Weather Conditions during Sampling

Outside temperature (°F) \_\_\_\_\_ Inside temperature (°F) \_\_\_\_\_

Prevailing wind speed and direction \_\_\_\_\_

Describe the general weather conditions (e.g. sunny, cloudy, rain) \_\_\_\_\_

Significant precipitation (0.1 inches or more) within 12 hours of the sampling event? \_\_\_\_\_

### General Comments

Is there any information you feel is important related to this site and the samples collected which would facilitate an accurate interpretation of the indoor air quality?

**APPENDIX D**  
**New Hampshire Department of Environmental Services**  
**Waste Management Division**  
**Site Remediation Programs**

**Indoor Air Sampling Protocol**

**Introduction**

Indoor air sampling for specific volatile organic compounds (VOC) can be performed to assist in determining if a contaminant is adversely affecting indoor air quality in a building. In general, certain conditions should be met and certain procedures should be followed to ensure integrity of the test results and to limit variables that may effect the success and interpretation of the data. This protocol is intended to ensure that air sampling data is collected in a consistent and useful manner during corrective action. The protocol outlines the steps to be followed when conducting indoor air sampling for VOCs in a residential setting however it may be modified for use in other situations. The resulting data obtained will provide a conservative indication of health risks posed to building occupants; however DES understands that under emergency response actions it may not be appropriate to complete the 24-hour pre-sampling inspection procedures outlined below. DES recommends that an indoor air sampling work plan be submitted to the department for comment prior to sampling unless the sampling is being conducted as part of an emergency response action.

**Pre-sampling Inspection**

A pre-sampling inspection and product inventory should be performed prior to sampling in order to characterize the structure layout and physical conditions of the home under evaluation. DES recommends completing the pre-sampling inspection 24 hours prior to sampling. In addition the inspection will allow for the identification of potential interfering sources of VOCs that may make data interpretation difficult. If the target VOCs are petroleum-related, interfering sources can include gasoline cans, gasoline powered equipment, paints and cleaning supplies containing petroleum distillates. If the target VOC is non-petroleum, such as tetrachloroethylene, other products or conditions that may be sources of these compounds, such as recently dry cleaned clothes, should be identified. Removing potential sources of VOCs from the indoor environment prior to testing is the most effective means of reducing interferences. If potential interferences can not be eliminated prior to sample collection it may make data interpretation more difficult. Field screening of potential sources may help to document if the sources are contributing to indoor air VOC concentrations and may help determine which sources should be removed prior to sampling.

If interfering sources are removed, DES then recommends ventilation of the building prior to testing to eliminate residual contamination from the interfering sources. The house should be ventilated by opening windows and doors for a period of 10 to 20 minutes. DES does not recommend building ventilation where no interfering VOC sources are observed or if potential VOC sources can not be removed from the building. The inability to eliminate potential interferences may be justification for not sampling. The primary objective of the indoor air test is to obtain a representative sample that provides a conservative indication of the health risk posed to the occupants by the VOC associated with the spill. Ventilation of the building should be minimized in the 24 hours prior to and during sampling.

Many variables can influence indoor air sampling including air exchange rates, operation of the building HVAC system, hydrogeologic and meteorological conditions, household activities and chemical usage. All of these variables combine to create site-specific exposure conditions that should be considered in evaluating the indoor air sample results from a home. To account for these variations the following measures should be considered:

- Perform sampling in the lowest level of the structure where vapors are likely to enter, typically the basement or crawl space.
- Perform living area sampling in a room that is used regularly in the lowest level of the structure suitable for occupancy such as a living room, den or playroom.
- Avoid kitchens and laundry rooms where use of personal products and other chemical products may interfere with sample results.
- Close windows and outside doors and keep them closed as much as possible during sampling except for normal entry and exiting.
- Place indoor samplers on stands approximately 1 meter above the floor in a central part of the room away from heaters, heating vents, high humidity, exterior walls, drafts (vents, open doors, and windows, air conditioners, fans) and obstructions to air flow.
- Place the source area sampler near the spill or where vapors may be entering the home (most likely in the basement) approximately 1 meter above the floor.
- All sampling equipment should be placed away from family traffic patterns and out of reach of pets and children.
- Only operate air conditioning units that recirculate interior air.
- Samplers should not be placed close to attached garages, ash trays or other possible VOC sources that might provide results that do not reflect contamination related to the spill/vapor source under investigation.
- Remove or tightly seal obvious indoor sources of petroleum constituents and other VOC sources during indoor air sampling, such as fuels, paints, cleaning solvents and mothballs.
- Document household characteristics, resident activities and potential ambient sources that may influence indoor air sampling results by completing the "Indoor Air Sampling Form".
- Complete a sketch of sampling locations.

**The residents of the home should be given the instructions listed below to follow 24 hours prior to and during the sampling event:**

- **Do not** open any windows, fireplace openings or vents.
- **Do not** operate ventilation fans unless special arrangements are made.
- **Do not** smoke in the home.
- **Do not** use paints or varnishes.
- **Do not** use wood stove, fireplace or auxiliary heating equipment, e.g., kerosene heaters.
- **Do not** operate or store automobiles in an attached garage.
- **Do not** store containers of gasoline or oil within the house or attached garage (except for fuel oil tanks).
- **Do not** clean or polish furniture or floors with petroleum or oil-based products.
- **Do not** use air fresheners or odor eliminators.
- **Do not** engage in hobbies that use materials containing VOCs.
- **Do not** use cosmetics including hair spray, nail polish, nail polish removers, etc.
- **Do not** apply pesticides.

### **Quality Control/Quality Assurance**

Follow the manufacturer's guidelines for use of sampling equipment and holding times. Field blanks trip blanks and duplicate samples should be kept with and submitted with the samples. Analyze samples as soon as possible after sampling. Record general weather conditions during sampling including ambient temperature. Maintain chain-of-custody forms.

**Appendix E**  
**New Hampshire Department of Environmental Services**  
**Waste Management Division**  
**Site Remediation Programs**

**Derivation of the Indoor Air Screening Levels**

This appendix describes the assumptions, toxicity information, equations, indoor air background information and analytical reporting limits used by DES Environmental Health Program (EHP) to develop the indoor air screening levels, provided in Table 1. The approach described in this appendix can also be used to develop indoor air screening guidelines for chemicals not identified in Table 1. In addition, equations are provided in this appendix that can be used to conduct a site-specific risk assessment to determine the potential human health risk to a building occupant based on a site-specific exposure scenario.

The chemicals contained in Table 1 are those identified on DES's Site Remediation Programs Full List of Analytes for Volatile Organics. The list has been limited to those chemicals with inhalation based toxicity factors and a Henry's Law Constant of  $1 \times 10^{-5}$  atm-m<sup>3</sup>/mol or greater. EHP developed carcinogenic and non-carcinogenic risk based values for both a residential exposure scenario and a commercial work place exposure scenario using standard exposure factors to estimate contaminant concentrations in indoor air that are considered to be protective of human health. The risk based values were then compared to published background values (residential only) and low level reporting limits for USEPA Method TO-15-LL with the higher value selected as the indoor air screening value.

*Dose-Response Information*

Dose-response information provides a quantitative evaluation of the toxicity data and allows for characterizing the relationship between the inhaled concentration and the adverse health effect(s) in the exposed population. The scientific literature has been reviewed by various federal agencies and for certain chemicals these agencies have derived and reported dose-response values. Examples of these values include EPA's reference concentrations (RfC) and inhalation Unit Risk (URi).

Estimating the health effects from a mixture of chemicals is of particular concern since most sites contain two or more contaminants present at the same time. When more than a single contaminant is present there is the potential for a diverse array of interactive effects. Such interactions can be in the form of additive, antagonistic, synergistic or other interactive effects. Unfortunately, for most chemical mixtures there is a lack of toxicological data. In addition, when there is data available for mixtures it is difficult to evaluate the effects because of the infinite proportions that could be possible. Therefore, the dose-response values are based on experimental data from exposure to a single chemical and do not consider the effects of exposure to chemical mixtures.

The concentration of a chemical in the air that is inhaled and the amount that reaches the circulatory system and eventually the target organ(s) to elicit the toxic effect is dependent on many variables. These variables include the physiological and metabolic differences in the regions of the respiratory tract, genetic differences between individuals and the health status of the individual. In addition, the physiochemical properties of the inhaled chemical will also influence the systemic or tissue dose and ultimately the toxic effect. Because of the uncertainty involved with determining the tissue dose the

toxicity factors used to develop the risk-based screening guidelines are based on RfCs and URi, which were developed from inhalation studies. If there were no inhalation based toxicity values available from the identified sources EHP chose not to develop a risk-based screening guideline from an extrapolation of an oral toxicity value (cancer slope factor and/or reference doses) to an inhalation value with the exception of trichloroethylene (TCE).

“The RfC methodology used to estimate benchmark values for non-cancer toxicity of inhaled chemicals significantly departed from the RfD approach. The same general principles were used but the RfC methodology was expanded to account for the dynamics of the respiratory system as the portal of entry. The major difference between the two approaches therefore is that the RfC methodology includes dosimetric adjustments to account for the species-specific relationships of exposure concentrations to deposited/delivered doses. The physicochemical characteristics of the inhaled agent are considered key determinants to its interaction with the respiratory tract and ultimate disposition.” (USEPA 1994) In summary, a chemical may have a vastly different absorption, distribution, metabolism and portal of entry effect that is not captured by the extrapolation introducing greater uncertainty than values based on inhalation studies.

### **Toxicity Factors**

In 2003, the EPA’s Office of Solid Waste and Emergency Response (OSWER) issued Directive 9285.7-53, which provides recommended sources of toxicity data for developing screening levels for various media and conducting site-specific human health risk assessments. The hierarchy of toxicity information recommended by OSWER Directive 9285.7-53 is:

Tier 1– EPA’s Integrated Risk Information System (IRIS)

Tier 2 – EPA’s Provisional Peer Reviewed Toxicity Values (PPRTVs)

Tier 3 – Other (CAL EPA, ATSDR, HEAST)

The EPA’s IRIS database is the generally preferred source of URi and RfCs for evaluating inhalation exposure. The PPRTVs are provisional toxicity values recommended by EPA’s National Center for Environmental Assessment (NCEA). PPRTVs are the second recommended tier of toxicity values, however, EPA has restricted access to this database. When IRIS values were not available EHP consulted EPA Region 9’s Preliminary Remediation Goals (PRG) table, which contains the latest recommended toxicity factors according to the OSWER directive. Please note that the toxicity values identified on IRIS are frequently updated. It is incumbent upon the users of this guidance to check IRIS and EPA Region 9’s PRG Table to verify that the most current toxicity information is being used when completing site-specific human health risk assessments.

### *Carcinogenic Effects*

For carcinogenic chemicals an assumption is made that there are no thresholds and that exposure introduces some potential of developing cancer. The risk based values for carcinogenic chemicals are based on an excess lifetime cancer risk (ELCR) of one-in-one million (1.0E-6) exposed for a residential scenario that assumes an individual is exposed 22 hours per day, 350 days per year for a duration lasting 30 years. The risk based values for a commercial worker assumes exposure for 8 hours per day, 5 days per week for 50 weeks per year (250 days per year total) for a duration lasting 25 years.

EHP has elected to calculate the carcinogenic risk-based screening values using the URi. The URi defines quantitatively the relationship between the dose and the response and is defined as the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1  $\mu\text{g}/\text{m}^3$  in air.

### *Non-carcinogenic Effects*

For non-carcinogens a range of exposures are believed to exist that can be tolerated with little likelihood of expression of an adverse health effect. The dose-response value derived by the EPA to protect against non-carcinogenic threshold effects is the reference concentration (RfC). The RfC is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious non-cancer health effects during a lifetime." (USEPA IRIS)

For this guidance, EHP has selected 20 percent of the chronic non-cancer dose-response value as the risk-based non-cancer value for a residential scenario. For a commercial scenario, EHP used 20 percent of the adjusted RfC. The RfC was adjusted to account for the assumed exposure of 5 days per week for 50 weeks per year (250 days per year total) over a duration lasting 25 years. By using 20 percent of the adjusted RfC, the commercial risk based value is still below the full RfC and therefore potential of entry effects should not be a concern.

### *Screening Level Equations*

#### *Carcinogens:*

$$\text{Equation \#1} \quad C_{\text{cancer}} (\mu\text{g}/\text{m}^3) = (\text{TCR} * \text{AP} * \text{HD}) / (\text{EF} * \text{ED} * \text{URi} * \text{ET})$$

#### *Non-carcinogens:*

$$\text{Equation \#2} \quad C_{\text{non-cancer}} (\mu\text{g}/\text{m}^3) = (\text{HQ} * \text{RfC})$$

Where:

$C_{\text{cancer}}$	= target indoor air concentration for a carcinogen ( $\mu\text{g}/\text{m}^3$ )
TCR	= target cancer risk (1.0E-6)
AP	= averaging period carcinogens (25550 days)
HD	= hours in a day (hours/day)
EF	= exposure frequency (days/year)
ED	= exposure duration (years)
URi	= unit risk factor inhalation ( $\mu\text{g}/\text{m}^3$ )
ET	= exposure time (hours/day)
$C_{\text{non-cancer}}$	= target indoor air concentration for a non-carcinogen ( $\mu\text{g}/\text{m}^3$ )
HQ	= target hazard quotient (0.2)
RfC	= reference concentration ( $\mu\text{g}/\text{m}^3$ )

The carcinogenic and non-carcinogenic risk based values, for residential and commercial exposure scenarios are provided in Table E-1.

## Indoor Air Background Values

In order to take into account background levels of chemicals, DES reviewed two indoor air studies listed below.

- “Study of Volatile Organic Chemicals in Air of Fuel Oil Heated Homes.” New York State Department of Health, 1997-2003.
- “Background Indoor Air Levels of Volatile Organic Compounds (VOCs) and Air-Phase Petroleum Hydrocarbons in Massachusetts Residences,” completed by Rich Rago and Rose McCafferty, Haley & Aldrich, and Andy Rezendes, Alpha Analytical, presented to NHDES October 2005.

Where a chemical was detected in at least 25% of homes sampled in the studies noted above, the 75<sup>th</sup> percentile values for each study were compared and the lower value was selected to represent a residential background value for indoor air. The indoor air background values used in the derivation of the residential indoor air screening levels are presented in Table E-2.

## Selection of the Indoor Air Screening Levels

For the indoor air screening levels, DES took into account risk based values, method reporting limit and indoor air background values (residential only). For the development of the residential indoor air screening levels, DES compared the most conservative (lowest) risk based value, the EPA Method TO-15-LL reporting limit and a residential indoor air background value, where available. The higher of these values was selected to represent the residential indoor air screening levels provided in Table 1 of the guidance. For the development of the commercial indoor air screening levels DES selected the most conservative (lowest) risk based value compared to the EPA Method TO-15-LL reporting limit and selected the higher of the two values as the commercial indoor air screening levels provided in Table 1 of the guidance. The risk based values for residential and commercial exposures, EPA Method TO-15-LL reporting limit and the residential background values used to generate the indoor air screening levels are detailed in Table E-2.

## Site-Specific Risk Assessments

The risk-based indoor air values are based on conservative scenarios. A site-specific risk assessment can be conducted when an indoor air screening guideline is exceeded or when the exposure scenario is different from the scenario used to develop the risk-based screening guidelines. The object of the site-specific risk assessment is to evaluate the reasonable maximum exposed (RME) individual at the site which is the highest possible exposure that is reasonably expected to occur. The RME should be used for both the current and future uses of the building. To account for the different exposure scenarios possible the following formulas can be used to determine the potential risk at a site. Please note that these equations are to evaluate the inhalation pathway. If other media are impacted the risk from all other potential pathways should be included in a Method 3 risk characterization. Guidelines for conducting a Method 3 risk characterization are outlined in the DES Contaminated Sites Risk Characterization and Management Policy.

*Equation #3*     $ADE = C * ET * EF * ED * C1 * C2 / AP$



*Carcinogenic risk:*

Equation #4     $\text{Risk} = \text{ADE} * \text{UR}_i$

*Non-carcinogenic risk:*

Equation #5     $\text{HQ} = \text{ADE} / (\text{RfC})$

Where:

- ADE = average daily exposure ( $\mu\text{g}/\text{m}^3$ )
- UR<sub>i</sub> = inhalation unit risk ( $\mu\text{g}/\text{m}^3$ )<sup>-1</sup>
- C = concentration chemical specific ( $\mu\text{g}/\text{m}^3$ )
- ET = exposure time (hours/day)
- EF = exposure frequency (days/year)
- ED = exposure duration (years)
- C1 = conversion factor (day/hour) (0.042)
- C2 = conversion factor (year/day) (0.003)
- AP = averaging period (years)
  - carcinogens = 70 years
  - non-carcinogens = site-specific (ED)
- HQ = hazard quotient (chemical specific)
- RfC = reference concentration chemical specific ( $\mu\text{g}/\text{m}^3$ )

For multiple carcinogenic chemicals at a site the site-specific cancer risk should be totaled.

$\text{Risk}_T = \text{Sum Risk}_i$  (expressed to one significant figure)

Where:

- $\text{Risk}_T$  = the total cancer risk expressed as a unitless probability
- $\text{Risk}_i$  = the risk estimate for the  $i^{\text{th}}$  substance

If  $\text{Risk}_T$  is greater than  $1.0\text{E}-5$ , the DES considers the risk from the inhalation pathway to be significant.

When more than one non-carcinogenic substance is at the site the quantification of the non-cancer hazard can be determined by:

Hazard Index (HI)    =  $\text{Sum HQ}_i$

Where:

- HQ = hazard quotient ( $\text{ADE}_i/\text{RfC}_i$ )
- ADE = the intake for the  $i^{\text{th}}$  toxicant
- RfC = reference concentration for the  $i^{\text{th}}$  toxicant

The ADE and RfC are expressed in the same units and represent the same exposure periods. If the HI is greater than unity (1.0) as a consequence of summing several hazard quotients of similar value it

would be appropriate to segregate the compounds by effect on target organ and to derive a separate hazard indice for each target organ. Table E-1 contains the RfCs for chemicals listed in this guidance document. For chemicals not contained in this document the user should consult IRIS or EPA Region 9's RBC table.

For some chemicals there are both carcinogenic and non-carcinogenic toxicity factors available. For the development of screening guidelines EHP has calculated separate screening values using both types of toxicity values if available and selected the most conservative (lowest) to represent the risk-based screening guideline. The risk-based guideline is then compared to the reporting limit of EPA Method TO-15-LL. Please note that it is incumbent upon the risk assessor to account for both potential carcinogenic and non-carcinogenic end points in a site-specific risk assessment if appropriate.

### **Exposure Variables**

The exposure variables EHP typically recommends for the residential and occupational scenarios are identified below. Exposure parameters that are adjusted based on a site-specific basis should be protective of current and future use scenarios. When exposure parameters are different from those recommended in this guidance, DES encourages the use of EPA's Exposure Factors Handbook. If an exposure is expected to be less than seven years consideration should be given to using sub chronic RfCs from a published source. If a sub chronic RfC is not available, the chronic RfC should be used unless justification is provided for altering the chronic RfC.

#### *Residential:*

EF	= exposure frequency	=	350 days/year
ED	= exposure duration total	=	30 years
	= exposure duration average	=	9 years <sup>13</sup>
ET	= exposure time	=	22 hours/day

#### *Occupational:*

EF	= exposure frequency	=	250 days/year
ED	= exposure duration	=	25 years
ET	= exposure time	=	8 hours/day

TABLE E-1

Chemical	CAS No.	URI ( $\mu\text{g}/\text{m}^3$ )	Residential 1.0E-6 ELCR ( $\mu\text{g}/\text{m}^3$ )	Commercial 1.0E-6 ELCR ( $\mu\text{g}/\text{m}^3$ )	Source	RfC ( $\mu\text{g}/\text{m}^3$ )	Residential 20 % RfC ( $\mu\text{g}/\text{m}^3$ )	Commercial 20 % RfC ( $\mu\text{g}/\text{m}^3$ )	Source
Benzene	71-43-2	7.80E-06	0.34	1.57	IRIS	30	6.00	8.76	IRIS
Bromoform	75-25-2	1.10E-06	2.41	11.15	IRIS				
Bromomethane	74-83-9					5	1.00	1.46	IRIS
Carbon tetrachloride	56-23-5	1.50E-05	0.18	0.82	IRIS				
Chlorobenzene	108-90-7					60	12.00	17.52	PPRTV
1,2-Dichlorobenzene	95-50-1					200	40.00	58.40	HEAST
1,4-Dichlorobenzene	106-46-7					800	160.00	233.60	IRIS
1,1-Dichloroethane	75-34-3					500	100.00	146.00	HEAST
1,2-Dichloroethane	107-06-2	2.60E-05	0.10	0.47	IRIS				
1,1-Dichloroethylene	75-35-4					200	40.00	58.40	IRIS
Dichloromethane (Methylene chloride)	75-09-2	4.70E-07	5.65	26.09	IRIS	3000	600.00	876.00	HEAST
1,2-Dichloropropane	78-87-5					4	0.80	1.17	IRIS
Ethylbenzene	100-41-4					1000	200.00	292.00	IRIS
Ethylene dibromide	106-93-4	6.00E-04	0.004424	0.020440	IRIS	9	1.80	2.63	IRIS
Methyl ethyl ketone	78-93-3					5000	1000.00	1460.00	IRIS
Methyl isobutyl ketone	108-10-1					3000	600.00	876.00	IRIS
Methyl-t-butyl ether (MTBE)	1634-04-4	8.00E-7	3.3	15.3		3000	600.00	876.00	IRIS
Styrene	100-42-5					1000	200.00	292.00	IRIS
1,1,2,2-Tetrachloroethane	79-34-5	5.80E-05	0.05	0.21	IRIS				
Tetrachloroethylene	127-18-4	5.90E-06	0.45	2.08	Cal EPA	35	7.00	10.22	Cal EPA
Toluene	108-88-3					5000	1000.00	1460.00	IRIS
1,2,4-Trichlorobenzene	120-82-1					3.5	0.70	1.02	PPRTV
1,1,1-Trichloroethane	71-55-6					2200	440.00	642.40	PPRTV
1,1,2-Trichloroethane	79-00-5	1.60E-05	0.17	0.77	IRIS				
Trichloroethene	79-01-6	1.10E-04	0.02	0.11		40	11.68		NCEA
Trichloromethane (Chloroform)	67-66-3	2.30E-05	0.12	0.53	IRIS				
1,2,4-Trimethylbenzene	95-63-6					6	1.20	1.75	PPRTV
1,3,5-Trimethylbenzene	108-67-8			2.79		6	1.20	1.75	PPRTV
Vinyl chloride	75-01-4	8.80E-06	0.30		IRIS	100	20.00	29.20	IRIS
Total Xylenes	1330-20-7					100	20.00	29.20	IRIS
Naphthalene	91-20-3					3	0.60	0.88	IRIS

TABLE E-2

Chemical	CAS No.	Groundwater Screening Value GW-2 (µg/L)	Residential Soil Gas Screening Value (µg/m3)	Commercial Soil Gas Screening Value (µg/m3)	Residential Indoor Air Screening Value (µg/m³)	Commercial Indoor Air Screening Value (µg/m³)	Residential Indoor Air Background Value (µg/m³)	Residential Indoor Air Risk Based Value (µg/m³)	Commercial Indoor Air Risk Based Value (µg/m³)	Method Reporting Limit TO-15 LL (µg/m³)
Benzene	71-43-2	2,000	95	95	1.9	1.9*	1.9	0.34	1.57	0.64
Bromoform	75-25-2	2,000	120	550	2.4	11	NA	2.41	11.15	2.07
Bromomethane	74-83-9	10	50	73	1.0	1.5	NA	1.00	1.46	0.78
Carbon Tetrachloride	56-23-5	40	63	63	1.3	1.3	0.59	0.18	0.82	1.26
Chlorobenzene	108-90-7	3,000	600	880	12	18	NA	12	17.52	0.92
Chloroform	67-66-3	200	49	49	1.0	1.0	0.54	0.12	0.53	0.98
Dichlorobenzene 12-	95-50-1	20,000	2000	2900	40	58	NA	40	58	1.20
Dichlorobenzene 14-	106-46-7	50,000	8000	12000	160	230	0.54	160	234	1.20
Dichloroethane 11-	75-34-3	10,000	5000	7300	100	150	NA	100	146	0.81
Dichloroethane 12-	107-06-2	300	40	40	0.8	0.8	NA	0.10	0.47	0.81
Dichloroethylene 11-	75-35-4	1,000	2000	2900	40.0	58	NA	40	58	0.79
Dichloromethane (Methylene Chloride)	75-09-2	1,000	280	1300	5.6	26	4.2	5.65	26	1.74
Dichloropropane 12-	78-87-5	200	46	59	0.9	1.2	NA	0.80	1.17	0.92
Ethylbenzene	100-41-4	50,000	10000	15000	200	290	2.2	200	292	0.87
Ethylene dibromide	106-93-4	700	77	77	1.5	1.5	NA	0.004	0.02	1.54
Methyl ethyl ketone	78-93-3	50,000	50000	73000	1000	1500	7.3	1000	1460	1.47
Methyl isobutyl ketone	108-10-1	50,000	30000	44000	600	880	0.86	600	876	2.05
Methyl tert butyl ether	1634-04-4	10,000	280	770	5.6	15	5.6	3.3	15	1.80
Naphthalene	91-20-3	2,000	130	130	2.6	2.6	NA	0.60	0.88	2.62
Styrene	100-42-5	50,000	10000	15000	200	290	0.64	200	292	0.85
Tetrachloroethane 1122-	79-34-5	1,000	69	69	1.4	1.4	NA	0.05	0.21	1.37
Tetrachloroethylene (PCE)	127-18-4	80	68	100	1.4	2.1	1.1	0.45	2.08	1.36
Toluene	108-88-3	50,000	50000	73000	1000	1500	18	1000	1460	0.75
Trichlorobenzene 124-	120-82-1	1,000	190	190	3.7	3.7	NA	0.70	1.02	3.71
Trichloroethane 111-	71-55-6	20,000	22000	32000	440	640	1.1	440	642	1.09
Trichloroethane 112-	79-00-5	500	55	55	1.1	1.1	NA	0.17	0.77	1.09
Trichloroethylene (TCE)	79-01-6	50	54	54	1.1	1.1	NA	0.02	0.11	1.07
Trimethylbenzene 124	95-63-6	3,000	220	220	4.3	4.3*	4.3	1.20	1.75	0.98
Trimethylbenzene 135	108-67-8	1,000	85	88	1.7	1.8	1.7	1.20	1.75	0.98
Vinyl chloride	75-01-4	10	26	140	0.5	2.8	NA	0.30	2.79	0.51
Xylenes (mixed isomers)	1330-20-7	30,000	1000	1500	20.0	29	7.7	20	29	0.87

## **Appendix E References**

US EPA. October 1994. Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry. EPA/600/8-90/066F.

US EPA 2001. Trichloroethylene Health Risk Assessment: Synthesis and Characterization (External Review Draft). EPA/600/P-01/002A  
<http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=23249>

US EPA. Integrated Risk Information System (IRIS).  
<http://www.epa.gov/iriswebp/iris/index.html>

Provisional Peer Reviewed Toxicity Values for Superfund (PPRTV). <http://hhpprtv.ornl.gov/>

US EPA. October 2004. Region 9 Preliminary Remediation Goals.  
<http://www.epa.gov/region09/waste/sfund/prg/index.htm>

US EPA. August 1997. Exposure Factors Handbook. Office of Research and Development. EPA/600/P-95/002Fa.

NEW HAMPSHIRE  
DEPARTMENT OF ENVIRONMENTAL SERVICES

DRAFT

**EVALUATION OF SEDIMENT QUALITY  
GUIDANCE DOCUMENT**



April 2005



**NEW HAMPSHIRE  
DEPARTMENT OF ENVIRONMENTAL SERVICES**

**EVALUATION OF SEDIMENT QUALITY  
GUIDANCE DOCUMENT**

April 2005

Prepared by  
Lori S. Siegel, Ph.D.  
Watershed Management Bureau  
New Hampshire Department of Environmental Services  
29 Hazen Drive  
Concord, NH 03302-0095  
[www.des.nh.gov](http://www.des.nh.gov)

Michael P. Nolin  
Commissioner

Harry T. Steward, P.E.  
Director, Water Division



# EVALUATION OF SEDIMENT QUALITY

## BACKGROUND

This document paper sets forth DES guidance for the application of Surface Water Quality Standards to freshwater, estuarine, and marine sediments. The narrative standards of Env-Ws 1703.19 *Biological and Aquatic Community Integrity* and Env-Ws 1703.21 *Water Quality Criteria for Toxic Substances* are applicable to sediment chemistry and biology. In addition, Env-Ws 1703.08 *Benthic Deposits* applies to sediments and refers to the physical, chemical, and biological nature of these substrates.

Sediments found in streams, rivers, lakes, and estuaries are habitat for many forms of aquatic life. This bottom-dwelling aquatic life -- including, but not limited to, amphipods, bivalves, midges, polychaetes, oligochaetes, mayflies, and cladocerans -- is intimately linked via nutrient and energy exchange webs to additional ecological resources, including finfish, shellfish, birds and other wildlife associated with surface water ecosystems. Sediments can serve as a repository and source of persistent and potentially toxic inorganic and organic chemicals. Contaminated sediments may adversely impact these ecological resources or humans who consume these resources.

## APPLICABLE LAWS / REGULATIONS

### Env-Ws 1703.08 **Benthic Deposits**

- a. Class A waters shall contain no benthic deposits, unless naturally occurring.
- b. Class B waters shall contain no benthic deposits that have a detrimental impact on the benthic community, unless naturally occurring.

### Env-Ws 1703.19 **Biological and Aquatic Community Integrity**

- a. The surface waters shall support and maintain a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of similar natural habitats of a region.
- b. Differences from naturally occurring conditions shall be limited to non-detrimental differences in community structure and function.



## Env-Ws 1703.21 **Water Quality Criteria for Toxic Substances**

- a. Unless naturally occurring or allowed under part Env-Ws 1707, all surface waters shall be free from toxic substances or chemical constituents in concentrations or combinations that:
- (1) Injure or are inimical to plants, animals, humans or aquatic life; or
  - (2) Persist in the environment or accumulate in aquatic organisms to levels that result in harmful concentrations in edible portions of fish, shellfish, other aquatic life, or wildlife that might consume aquatic life.

## **GUIDANCE DOCUMENT**

### **Introduction**

Risk posed to sediment-dwelling organisms should be assessed according the Sediment Quality Triad approach, described in Section I below.

Certain contaminants in sediment may bioaccumulate in intermediate to higher trophic organisms. Associated risks, which increase if the contaminant has low water solubility and high lipid solubility ( $\text{Log } K_{ow} > 4.2$ ), should be assessed according to Section II on page 10. The document EPA-823-R-00-001 lists the “Important Bioaccumulative Compounds” (USEPA, 2000c). The EPA also addresses these persistent, bioaccumulative, and toxic pollutants (PBTs) according to their multimedia strategy, which aims to protect human and ecosystem health from these highly toxic, long-lasting substances. According to <http://www.epa.gov/opptintr/pbt/cheminfo.htm>, PBTs include, **but are not limited to:**

- |                     |                             |
|---------------------|-----------------------------|
| ● aldrin/dieldrin   | ● mercury and its compounds |
| ● benzo(a)pyrene    | ● mirex                     |
| ● chlordane         | ● octachlorostyrene         |
| ● DDT, DDD, DDE     | ● PCBs                      |
| ● hexachlorobenzene | ● dioxins and furans        |
| ● alkyl-lead        | ● toxaphene                 |

### **I. Sediment Quality Triad Approach for Sediment-Dwelling Organisms (addresses Env-Ws 1703.08 and 1703.19)**

Adverse effects on sediment aquatic life will be assessed using the Sediment Quality Triad approach (USEPA, 1992). This methodology integrates both chemical and biological data in

order to assess ecological resource risk. The methodology has three components that are applied sequentially and yield complementary data. The components are:

- A. Sediment chemical analyses
- B. Sediment toxicity bioassays (laboratory)
- C. Community assessment (field)

The Sediment Quality Triad (chemistry, toxicity, and community) will be performed as this guidance document specifies in the description of each component. As outlined in the flowchart presented in Figure 1, the assessor will weigh the results of each component, as it becomes necessary to perform, to conclude whether or not the chemical contamination is impacting the benthic community. Considering the weight of evidence, the decision making process follows a matrix of outcomes (Table 1) that, if applicable, also considers the characterization of bioaccumulation risk, as determined according to Section II.

While an exceedance of the appropriate thresholds, determined in Component A of the triad, mandates further risk characterization, the severity of the risk may be so strongly predictive of impairment that the waterbody will be listed as impaired if not further characterized within an assessment period. With further characterization, the assessor may assume that Component B will reveal sediment toxicity. In this case, the assessor could skip Component B and proceed directly to Component C, i.e., community assessment. However, if the community assessment does not reveal any impact, the assumption of positive sediment toxicity must figure into the weight of evidence and typically mandates at least continued monitoring of the site for future impacts. Justification to omit Component B without this mandate may be made site-specifically. For example, any impacts would already have occurred at a site where the contamination source has been eliminated and sediment contaminants have been present for a significant (depending on site conditions) length of time. This determination will be made at the discretion of DES. Another option would be to perform Components B and C concurrently.

In the case of free product and observable ecological impacts that clearly indicate a violation of water quality standards, it may be more efficient to initially skip the triad and move directly to remediation. Following remediation, as a performance standard to ensure effectiveness, sediment sampling should be performed and the triad applied as applicable.

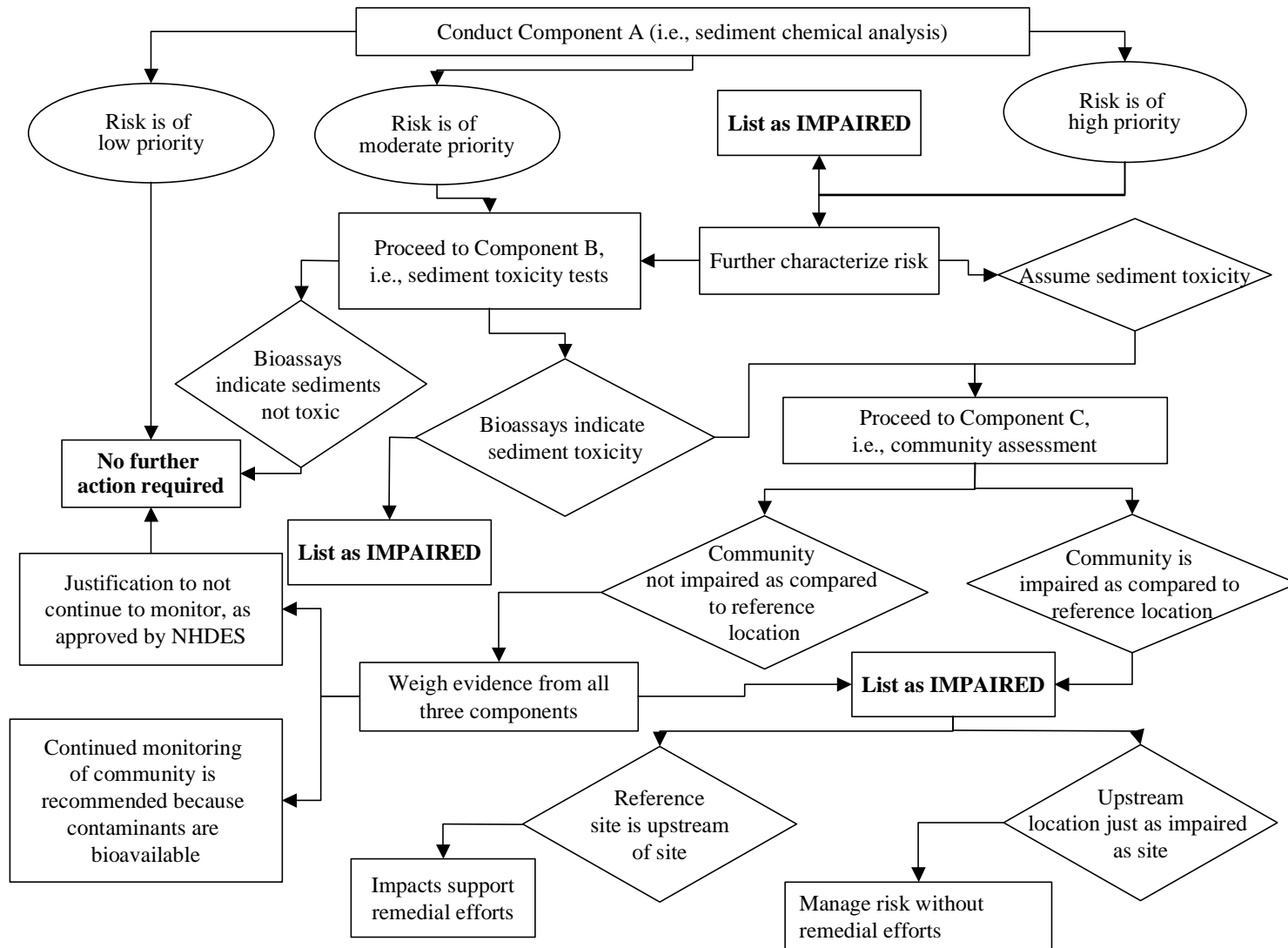


Figure 1 Flowchart of Triad Approach

## Triad Components

### A. Conduct sediment chemical analyses. Chemical profiles of sediment samples are compared with standard screening level reference values.

Sediment samples shall be collected in accordance with standard protocols (e.g., USEPA EPA-823-B-01-002, 2001; refer to [www.epa.gov/waterscience/cs/collection.html](http://www.epa.gov/waterscience/cs/collection.html) for downloading this manual). The two main categories of sampling equipment are coring and grab devices. Data quality objectives and site specifics control the choice of sampling equipment.

Besides chemical concentrations, total organic carbon (TOC) and grain size should be quantified for each sample. The spatial distribution of contaminants at the site should be evaluated and compared to that at a reference near the site yet not impacted by the site, i.e., local conditions. If evidence suggests the concentrations of contamination of potential concern exceed those of local conditions, chemical concentrations of samples will be compared with published, peer-reviewed screening level contaminant lists, which include, but are not limited to:

- 1) NOAA 1999 – SQuiRT Tables (NOAA Hazmat Report 99-1).
- 2) Oak Ridge National Laboratory 1997 – Toxicological Benchmarks (ORNL ES/ER/TM-95/R4).
- 3) US Environmental Protection Agency 1996 – Ecotox Thresholds (USEPA EPA 540/F-95/038).
- 4) MacDonald *et al.*, 2000 – Arch. Environ. Contam. and Toxicology Vol 39: 20-31.

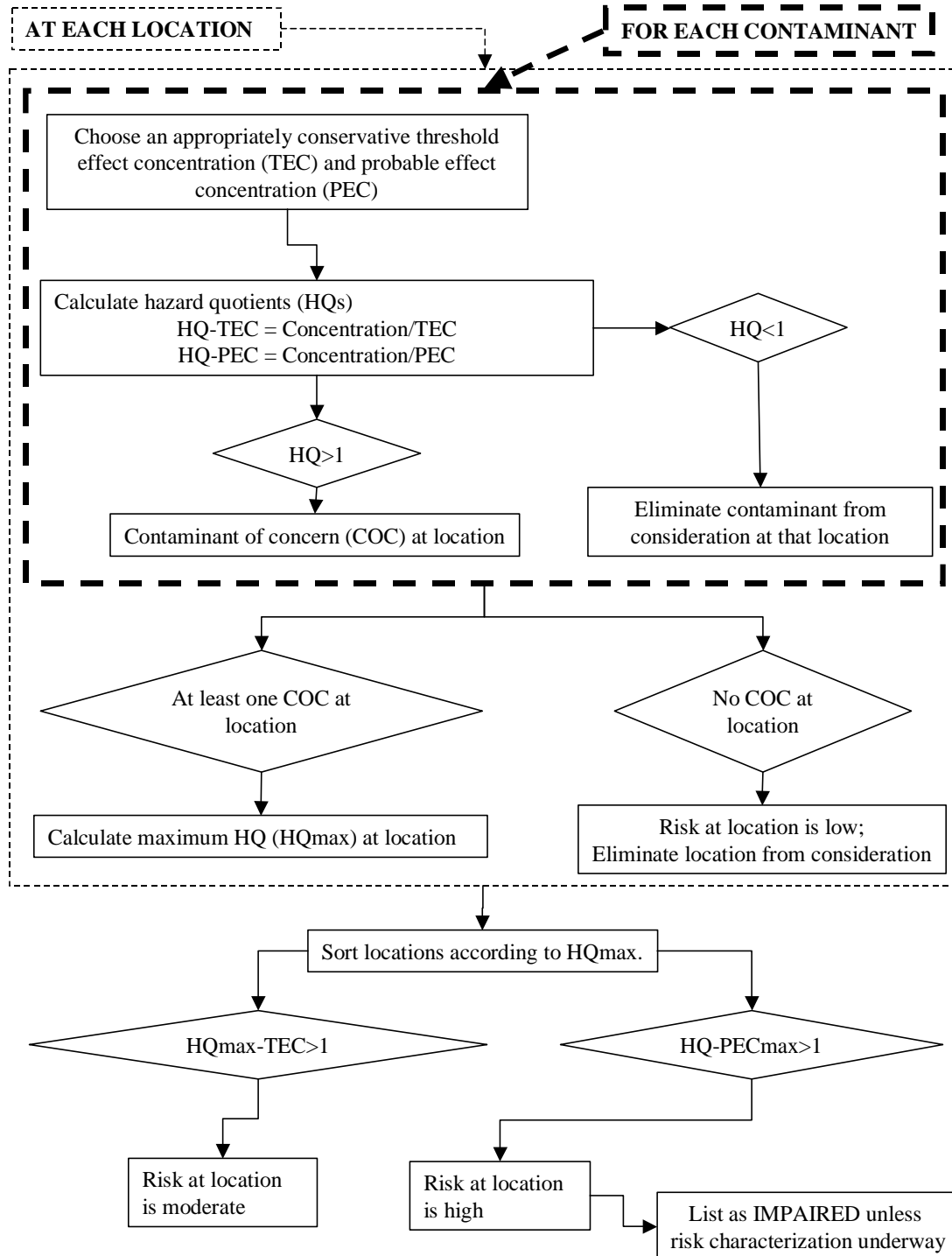
The following steps, as outlined in the flowchart presented in Figure 2, specify the sequence of events for screening at each sediment sampling location. The number of sample locations increases the statistical significance of the site risk characterization. Contaminants that have the potential to bioaccumulate must be further evaluated according to Section II.

### Steps

1. For each contaminant, choose an appropriately conservative **THRESHOLD EFFECT CONCENTRATION (TEC)** and **PROBABLE EFFECT CONCENTRATION (PEC)** from available guidelines for each contaminant of concern. TEC values are screening thresholds **below which adverse effects are unlikely**. Data are typically from studies with sensitive species in laboratory exposures. PEC values are screening thresholds **above which adverse effects are likely**. For freshwater environments, although consensus-based (CB) TEC and PEC values (MacDonald *et al.*, 2000) are not the most conservative, they do have the most statistical justification. Assessors may choose thresholds from other sources provided they are at least as conservative as the CB thresholds. For contaminants with no available threshold, calculate a standard using the contaminant's surface water standard with appropriate partitioning coefficients.

For less sensitive ecosystems, as determined site-specifically and approved by DES in advance, comparisons to the contaminant's PEC alone may suffice.

2. Calculate the hazard quotient (HQ) for each contaminant detected in each sample by dividing the sediment contaminant concentration by the threshold value. An HQ calculated with a TEC (HQ-TEC) of one or greater indicates the possibility that the contaminant may adversely affect sediment organisms. An HQ calculated with a PEC (HQ-PEC) of one or greater indicates the likelihood that the contaminant will adversely affect sediment organisms.
3. According to Section II, contaminants with high bioaccumulative potential that have  $HQ > 1$  (HQ calculated with TEC) or for which a TEC is not available, must concurrently assess the risk to higher trophic organisms.
4. Qualify risk from each contaminant according to HQ as low ( $HQ-TEC < 1$ ), moderate ( $HQ-TEC > 1$ ), and high ( $HQ-PEC > 1$ ). Contaminants classified as moderate to high risk are retained as contaminants of concern (COCs).
5. If the sample location has at least one COC, determine its maximum HQ ( $HQ_{max}$ ) calculated with TEC and PEC (or just with PEC if approved by NH DES) and proceed to Step 6. Otherwise, eliminate that location from concern.
6. Include the location in the priority list for further assessment according to its maximum level of risk. Qualify risk at each location as moderate ( $HQ-TEC_{max} > 1$ ) or high ( $HQ-PEC_{max} > 1$ ). Moderate to high risk may indicate a surface water quality violation.
7. Sample locations with moderate risk priority require additional risk characterization according to Component B of the triad. Sample locations with high-risk priority are assumed to be impaired and will be listed as such unless additional risk characterization according to Components B and/or C suggest otherwise.



**Figure 2 Flowchart of Component A of Triad Approach**

## **B. Conduct sediment toxicity bioassays using sediment samples from potentially impacted sites**

Additional sediment samples will be collected by standard protocols (e.g., USEPA EPA – 823-B-01-002, 2001) and used in standard sediment acute and chronic toxicity tests (e.g., EPA 600/R-99/064, 2000, EPA 600/R-01/020, 2001, EPA 600/R-94/025) with test organisms most appropriate for the site. Typical test organisms appropriate for freshwater environments include the amphipod *Hyaella azteca* (*H. azteca*) and the chironomids *Chironomus dilutus* (*C. dilutus*) (formerly known as *C. tentans*) and *Chironomus riparius*. Typical test organisms appropriate for marine environments include the amphipods *Rhepoxynius abronius*, *Eohaustorius estuaries*, *Ampelisca abdita*, and *Grandidrerella japonica*. More than one organism should be evaluated for each sample location. Sample methodology, toxicity test, and test organism(s) are subject to review and approval by DES. If sample collection is not feasible due to sediment characteristics, alternative analyses, e.g., pore water analyses/toxicity, may be substituted for sediment toxicity bioassays, but only upon prior approval by DES.

Although assessment endpoints are site-specific, an effect of 20 percent on the endpoint will indicate positive toxicity. In particular, a decrease in survival of more than 20 percent is generally unacceptable (Kuhn *et al.* 2002; Long *et al.*, 2001). However, when growth is the endpoint, literature (e.g., Kubit *et al.*, 1996) supports a growth inhibition of an organism of 25 percent to be indicative of non-lethal effects.

Potential endpoints are a function of the duration of the bioassay. Tests may be categorized as acute (e.g., 48 to 96 hours), short-term chronic (e.g., 10 days), or long-term chronic (e.g., at least 20 days). The chronic bioassays are critical to evaluate impacts on survival and growth. Cost and time considerations associated with this requirement have typically rendered the 10-day bioassay to be performed. However, toxicity is sometimes observed only after this test would be terminated, as indicated by the long-term chronic test. Research suggests and the NH DES now recommends that, at a minimum, the long-term chronic bioassay be conducted for at least one of the organisms for samples from certain key locations. Survival and growth must be reported at the short-term and long-term marks. If significant toxicity is observed at the short-term mark, the test may be terminated then.

In the event that laboratory testing reveals acute or chronic sediment toxicity, the assessment may progress to Component C, i.e., benthic community assessment, or be deemed to pose risk. The ability and practicality of performing this third component with enough statistical power for relatively small sites, which are more typical than not at the State level, may eliminate its merit. The triad approach for which the evidence is also weighed supports the approach that if the chemistry and bioassays lead to a benthic assessment but that assessment is not rigorous enough, then the site will still be considered impacted. If chemistry indicates moderate risk, i.e.,  $HQ-TEC > 1 \geq HQ-PEC$ , and bioassays indicate toxicity, then the benthic assessment may be the deciding factor. However, if chemistry indicates high risk, i.e.,  $HQ-PEC > 1$ , and bioassays indicate toxicity, then the benthic assessment is not likely robust enough to outweigh the evidence of risk and may be omitted. Furthermore, sites where the

aquatic chemistry is likely to change dramatically, such as for a dam removal project, may render Component C irrelevant.

On the contrary, negative toxicity for samples with high risk potential according to Component A should be considered cautiously. Prior to accepting the results, the assessor should exclude reasons for false negatives, .e.g., poor choice in test organism.

### **C. Conduct an assessment of community integrity**

A community assessment must involve a field evaluation of the sediment community. Specifically, it is necessary to conduct a sediment biological community survey at the sampling site and compare the results with those from an appropriate, less adversely impacted reference site. The composition and structure of the benthic community will be characterized at the sample location and compared to a survey or surveys at a reference location of similar habitat but subject to less of the chemical contaminants. Standard ecological community metrics will be used to characterize the biota at both locations. The methods for benthic biological survey shall be reviewed and approved by DES in advance.

The reference location is used as a comparison to determine the level of actual risk to the site. The reference is a location that is neither impacted by the site nor by other sources. The comparison of contaminant spatial distributions for Component A may aid in locating the reference. For a river, brook, or stream, it is preferably upstream of the site. If such a location cannot be found near the site, then the reference location should be chosen from a similar watershed and metrics extrapolated to the site. If results of this comparison suggest the site is in fact impaired, a nearby location that is not impacted by the site, despite its impairments from other sources, should also be characterized as a control site so that the risk manager may make an informed decision about the relative increase in risk that is posed by the site. The risk at the site may not warrant remedial actions if nearby locations are just as impaired from other sources. Nevertheless, it is still important to understand the level of risk at hand as determined by comparison to the reference site.



## II. Bioaccumulation Risk Potential (addresses Env-Ws 1703.21)

Sediment contamination can have adverse ecological effects on the benthic community and on shellfish, finfish, avian, amphibian, reptile, and/or mammal communities that are linked to benthic communities via the food web structure. Free-swimming organisms may bioconcentrate contaminants directly from the water column. However, they may also bioaccumulate contaminants via direct or indirect sediment exposure or diet.

Through the ecological processes of *bioaccumulation* (organism intake of contaminants via both water column and diet) and *biomagnification* (increased organism body burden of persistent contaminants as we move to higher trophic levels in ecosystems) contaminants in the sediments may be transferred to shellfish, finfish, avian, and terrestrial wildlife communities associated with the contaminated aquatic systems. Predator fish, birds, and other wildlife may become contaminated from being linked to bottom-feeding fish or benthic invertebrates that are laden with sediment associated pollutants via food-web transfer. This transfer can continue to human beings if contaminated fish, birds, or mammals are consumed.

The risk of bioaccumulation from sediments increases if the contaminant has low water solubility and high lipid solubility ( $\text{Log } K_{ow} > 4.2$ ). Heavy metals or non-polar organic chemicals, which may bioaccumulate to toxic levels in shellfish, finfish, and birds or render organisms unfit for human consumption, generally will be located in the sediments of aquatic systems. Detailed information on the chemistry and toxicity of many of the most common bioaccumulative contaminants is provided in USEPA EPA-823-R-00-001, 2000c and EPA-823-R-00-002, 2000a.

A sediment contaminant with bioaccumulation potential and, if a TEC is available, HQ-TEC > 1 (determined in Component A of the triad) mandates the evaluation of actual or predicted tissue concentrations for assessment of adverse impact on relevant organisms. Relevant organisms include those species that use the contaminated site for resting, feeding, rearing, or reproduction.

### A. Determine contaminant tissue concentrations for relevant organisms

Three alternative methods are available to determine contaminant tissue concentrations for relevant organisms of intermediate to higher trophic levels.

1. Use published **Biota-Sediment Accumulation Factors (BSAFs)** to estimate tissue concentrations of contaminants for relevant organisms.

The National Sediment Quality Survey, 2<sup>nd</sup> Edition (USEPA EPA-823-R-01-01, 2000c) provides **BSAFs** for fish tissue for numerous heavy metal and non-polar organic contaminants. The Appendix to Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment (USEPA EPA-823-R-00-002, 2000a) contains additional **BSAFs** for finfish, shellfish, birds, invertebrates, plants, and other organisms.

2. Use approved models to predict tissue concentrations for relevant organisms.

Bioaccumulation of heavy metals or non-polar organic contaminants in fish or other organisms can be predicted from sediment concentrations using equilibrium (e.g. Thomann *et al.*, 1992), fugacity (e.g., Burmaster *et al.*, 1991), or other appropriate models approved by DES.

3. Use direct measurement to determine tissue concentration of contaminants for relevant organisms.

Direct tissue measurement is the most confident approach to determine bioaccumulation in aquatic organisms or aquatic-dependent wildlife. Direct determination can be conducted using either laboratory-exposed or field-collected organisms. For organic contaminants with a  $\text{Log } K_{ow} > 6.5$ , there is a loss of linear relationship between  $K_{ow}$  and bioaccumulation. This results in uncertainty in modeled predictions of biological uptake. For contaminants with  $K_{ow} > 6.5$ , direct measurement is the preferred method for assessing bioaccumulation.

#### **B. Compare tissue contaminant concentrations with published acute and chronic toxicity values and calculate risk ratios for relevant organisms.**

Acute and chronic toxicity values for ecological resources are available in numerous publications and databases. TOXNET (<http://www.toxnet.nlm.nih.gov/>) is sponsored by the National Library of Medicine and contains a cluster of databases on toxicology, hazardous chemicals, and related topics. The USEPA developed ECOTOX ([http://www.epa.gov/med/databases/databases\\_text.html](http://www.epa.gov/med/databases/databases_text.html)). This database integrates AQUIRE, PHYTOTOX and TERRETOX, which are three databases that contain ecotoxicity information for aquatic life, terrestrial plants, and wildlife, respectively. Sample *et al.* (1996) provides toxicological benchmarks for wildlife. The US Army Corps of Engineers developed the Environmental Residue-Effects Database (ERED) (<http://www.wes.army.mil/el/ered/index.html>). It is a compilation of data from 736 studies published between 1964 and 2001 on the biological effects of many environmental contaminants found in tissues of organisms in which the effects were observed.

Risk ratios are calculated by dividing organism tissue concentrations by appropriate acute and/or chronic toxicity levels. Risk quotients of one or greater indicate the possibility of adverse effect of the contaminant on the organism. This latter outcome may indicate a Surface Water Quality violation and necessitate further action, which may be remediation, restoration, or monitoring, depending on the specifics of the site.

**TABLE 1: MATRIX OF RISK CHARACTERIZATION ACCORDING TO THE SEDIMENT QUALITY TRIAD AND BIOACCUMULATION POTENTIAL**

Triad Components			Bioaccumulation Potential	Outcome
A. Chemistry	B. Toxicity	C. Benthic Community		
+	-	Not Assessed	Not Assessed	Sediment contaminants are not adversely impacting the benthic community.
+	+(or not assessed)	-	Not Assessed	Weigh the evidence to characterize risk. If sufficient weight to Component C, the benthic community may still be at future risk for adverse impact due to sediment chemistry, requiring continued monitoring to evaluate future impacts. <sup>1</sup> Contaminant characteristics do not warrant bioaccumulation assessment.
+	+(or not assessed)	-	-	Weigh the evidence to characterize risk. If sufficient weight to Component C, the benthic community may still be at future risk for adverse impact due to sediment chemistry, requiring continued monitoring to evaluate future impacts. <sup>1</sup> Contaminant characteristics warrant bioaccumulation assessment but impact to relevant organisms is not expected.
+	+(or not assessed)	+(or not assessed)	Not Assessed	Sediment contaminants at the site are adversely impacting the benthic community. <sup>2</sup> Contaminant characteristics do not warrant bioaccumulation assessment.
+	+(or not assessed)	+(or not assessed)	-	Sediment contaminants at the site are adversely impacting the benthic community. <sup>2</sup> Contaminant characteristics warrant bioaccumulation assessment but impact to relevant organisms is not expected.
+	+(or not assessed)	+(or not assessed)	+	Sediment contaminants at the site are adversely impacting the benthic community and bioaccumulation of sediment-associated contaminants has the potential to adversely impact relevant organisms. <sup>2</sup>
+	-	Not Assessed	+	Sediment contaminants at the site are not adversely impacting the benthic community, but bioaccumulation of sediment-associated contaminants has the potential to adversely impact relevant organisms. <sup>2</sup>

<sup>1</sup> A monitoring plan will be presented to DES for approval.

<sup>2</sup> This outcome indicates a surface water quality violation and necessitates further action, which may be remediation, restoration, or monitoring, depending on the specifics of the site.

## **GLOSSARY**

BCF – Biological concentration factor; ratio of tissue residue to water column concentration at steady state.

BSAF - Biota-sediment accumulation factor; ratio of tissue residue to sediment concentration at steady state normalized to lipid and sediment organic carbon.

Biomagnification - A special case of bioaccumulation where body burdens of contaminants, normalized to an organisms lipid content, increase at successive, higher levels of an ecosystem's food web.

CB – Consensus-based; geometric mean of thresholds from a variety of sources, providing a more statistically based threshold.

COC - Contaminant of concern.

HQ- Hazard quotient; contaminant concentration divided by screening threshold concentration.

PBTs - Persistent, bioaccumulative, and toxic pollutants.

TEC - Threshold effect concentration; screening thresholds below which adverse effects are unlikely.

PEC - Probable effect concentration; screening thresholds above which adverse effects are likely.

## REFERENCES

- Burmester, D. E., C. A. Menzie, J. S. Freshman, J. A. Burns, N. I. Maxwell, and S. R. Drew. 1991. Assessment of methods for estimating aquatic hazards at Superfund type sites: A cautionary tale. *Environ. Toxicol. Chemistry* 10: 827-842.
- Ingersoll, C.G. and MacDonald, D. D. 2001. A Guidance Manual to Support the Assessment of Contaminated Sediments in Freshwater, Estuarine, and Marine Ecosystems: Volume 3 – Interpretation of the Results of Sediment Quality Investigations.
- Kubitz, J.A., J.M. Besser, and J.P. Giesy. 1996. A two-step experimental design for a sediment bioassay using growth of the amphipod *Hyaella azteca* for the test end point. *Environmental Toxicology and Chemistry*. 15(10):1783–1792.
- Kuhn, A., W.R. Munns, Jr., J. Serbst, P. Edwards, M.G. Cantwell, T. Gleason, M.C. Pelletier, and W. Berry. 2002. Evaluating the ecological significance of laboratory response data to predict population-level effects for the estuarine amphipod *Ampelisca abdita*. *Environmental Toxicology and Chemistry*. 21(4):865-874.
- Long E.R., C.B. Hong, and C.G. Severn. 2001. Relationship between acute sediment toxicity in laboratory tests and abundance and diversity of benthic infauna in marine sediments: A review. *Environmental Toxicology and Chemistry*. 20(1):46–60.
- MacDonald, D. D., C. G. Ingersoll, and T. A. Berger. 2000. Development and evaluation of consensus-based sediment quality guidelines for freshwater ecosystems. *Arch. Environ. Contam. And Toxicol.* 39: 20-31.
- NHDES. 2002. WD-02-9. Evaluation of Sediment Quality Policy. New Hampshire Department of Environmental Services. Watershed Management Bureau. September, 2002.
- NOAA (National Oceanic and Atmospheric Administration) (M. F. Buchman). 1999. NOAA Screening Quick Reference Tables. Coastal Protection and Restoration Division. NOAA HAZMAT Report No. 99-1. Seattle, WA, 12pp.
- ORNL (Oak Ridge National Laboratory). 1997. Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment Associated Biota: 1997 Revision. Publica. No. ES/ER/TM-95/R4. ORNL, Oak Ridge, TN, 31 pp.
- Sample, B. E., D. M. Opresko, and G. W. Suter III. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory. Publication No. ES/ER/TM-86/R3. Oak Ridge, TN

Thomann, R. V., J. P. Connolly, and T. F. Parkerton. 1992. An equilibrium model of organic chemical accumulation in aquatic food webs with sediment interaction. *Environ. Toxicol. Chemistry*. 11: 615-629.

USEPA. 1994. Methods for Assessing the Toxicity of Sediment-associated Contaminants with Estuarine and Marine Amphipods. Office of Water. Publica. No. EPA-600/R-94-025, Washington, DC, 192 pp.

USEPA. 1996. ECO-UPDATE – Ecotox Thresholds. Office of Solid Waste and Emergency Response. Publica. No. 9345.0-12FSI, EPA-540/F-95/038. Washington, DC, 12 pp.

USEPA. 2000a. Appendix to Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Status and Needs. Chemical-Specific Summary Tables. Office of Water, Publica. No. EPA-823-R-00-002. Washington, DC, 816 pp.

USEPA. 2000b. Methods for Measuring the Toxicity and Bioaccumulation of Sediment-Associated Contaminants with Freshwater Invertebrates. 2<sup>nd</sup> Edition. Office of Research and Development, Publica. No. EPA-600/R-99/064, Washington, DC, 192 pp.

USEPA. 2000c. Bioaccumulation Testing and Interpretation for the Purpose of Sediment Quality Assessment. Status and Needs. Office of Water, Publica. No. EPA-823-R-00-001, Washington, DC, 111 pp.

USEPA. 2001a. Methods for Assessing the Chronic Toxicity of Marine and Estuarine Sediment-associated Contaminants with Amphipod *Leptocheirus plumulosus*. Publica. No. EPA-600/R-0/020. Washington, DC, 103 pp.

USEPA. 2001b. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Office of Water. Publica. No. EPA-823-B-01-002. Washington, DC.

USEPA. 2001c. The Incidence and Severity of Sediment Contamination in Surface Waters of the United States. Office of Science and Technology. Publica. No. EPA-823-R-01-01, Washington, DC.

**Approved:** \_\_\_\_\_  
Harry Stewart, P. E., Director  
Water Division  
NH Department of Environmental Services

Date: \_\_\_\_\_

**APPENDIX D**

**NHDES LABORATORY'S**

**CHAIN OF CUSTODY FORM**

# NH DES LABORATORY SERVICES LOGIN AND CUSTODY SHEET

(Laboratory Policy: Samples not meeting method requirements will be analyzed at the discretion of the NH DES Laboratory.)

LAB ACCOUNT (Billing) # \_\_\_\_\_ One Stop (PROJECT) ID# \_\_\_\_\_ DES Site Number \_\_\_\_\_ Temp. ° C. \_\_\_\_\_

Description: \_\_\_\_\_ Town: Troy NH NHDES Contact & Phone#: \_\_\_\_\_

Comments: Temperature Blank included yes or no (Please circle) Contractor Contact & Phone # \_\_\_\_\_

Collected By & Phone#: \_\_\_\_\_

Sample Location /ID	Date/Time Sampled	# of Containers	Matrix															Other / Notes	Lab ID # ( For Lab Use Only )

Preservation: \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date and Time \_\_\_\_\_ Received By \_\_\_\_\_ Matrix: A= Air S= Soil SED = Sediments AQ= Aqueous Other: \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date and Time \_\_\_\_\_ Received By \_\_\_\_\_

Relinquished By \_\_\_\_\_ Date and Time \_\_\_\_\_ Received For Laboratory By \_\_\_\_\_

Page \_\_\_\_\_ of \_\_\_\_\_

Data Reviewed By \_\_\_\_\_ Date \_\_\_\_\_

Section No.: 22.0  
Revision No.: 5 (HWRB)  
Date: 11-2-06  
Page 1 of 1



**APPENDIX E**  
**WELL SAMPLING WORKSHEET**  
**HAZARDOUS WASTE REMEDIATION BUREAU**

# Well Samnpling Worksheet

Page \_\_\_\_ of \_\_\_\_

<b>Date :</b> _____ Field Personnel _____ Purging Device (pump type) _____ Well Depth (ft): _____ Screen Length in ft. _____ Depth to GW (ft): _____ From: _____ Pump Intake set (ft): _____ From: _____ Weather Conditions and Notes: _____ _____ _____ _____ _____	<b>Well ID :</b> _____ Purging Start Time : _____ Total Purge Volume (ml): _____ Parameter Stabilization: (Circle) <b>Yes / No</b> Two Hour Time Limit Reached ? (Circle) <b>Yes / No</b> Time at Sample Completion: _____ Signature: _____
---	---

Clock Time	Purge Rate	Temp. +/- 3%	Spec. Cond. +/- 3%	pH +/- 0.1	ORP +/-10	DO +/- 10%	Turbidity +/- 10% if > 1	Depth to Water Surface	Draw down	Cum. Draw down	Bladder Refill Rate	Bladder Discharge Rate	Pressure (PSI) or Pump Speed	Comments/Adjustments
(24 HR)	(ml/min)	(°C)	(µS/cm)	units	(mV)	(mg/L)	(NTU)	(ft)	(ft)	(ft)	setting	setting		

Notes: All depths in feet below top of PVC unless specified. NR = No Reading

Tubing Factors: Milliliters to purge standing water in tubing      1/2" ID: height in ft.x 38.59 = ml needed      1/4" ID: height in ft.x 9.64 = ml needed      1/8" ID: height in ft. x 2.41 = ml needed

**APPENDIX F**  
**EXAMPLE OF A SAP OUTLINE**

## **SAP OUTLINE EXAMPLE**

All SAPs (QAPP Addendums) shall include the following information.  
See the QAPP text and other QAPP Appendixes for examples of Tables identified here to be included in the SAP

TITLE PAGE

SIGNATURE PAGE

TABLE OF CONTENTS

### **1.0 INTRODUCTION**

- 1.1 Site Description and History
- 1.2 Contaminants of Concern
- 1.3 Interim Cleanup Levels (ICLs) & Ambient Groundwater Quality Standards (AGQS)
- 1.4 Data Quality Objectives

### **2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES**

Description of responsibilities including an Organization Chart

### **3.0 MONITORING AND SAMPLING**

Multi-Media Sampling and Analysis (as appropriate)

- 3.1 Groundwater Sampling
- 3.2 Surface Water Sampling
- 3.3 Sediment Sampling
- 3.4 Pore Water Sampling
- 3.5 Residential Sampling

### **4.0 QUALITY CONTROL**

- 4.1 Equipment Calibration and Maintenance
  - Table listing equipment, maintenance and frequency
  - Table listing equipment, calibration frequency, calibration standards, calibration acceptance criteria and corrective action
- 4.2 Field Quality Control
  - Table listing QC samples, frequency, acceptance criteria and corrective action
- 4.3 Data Verification and Validation
  - Including Data Usability
- 4.4 Quality Assurance Field Audits
  - Including frequency of internal and external assessments

### **5.0 DOCUMENTATION**

- 5.1 Field Data Management – Documentation of Field Activities
- 5.2 Chain-Of-Custody Procedures
- 5.3 Reports
  - Specify type, number and contents
  - Must include a Quality Assurance/Quality Control Section (statements summarizing whether or not the quality control criteria in the SAP & QAPP were met in the field and in the lab. Listing any QA/QC problems and how they were

resolved. Noting anything unusual that will affect the quality or usability of the data.

## **6.0 REFERENCES**

### **FIGURES**

Site Lotus

Map(s) of all sampling locations, including residential sampling locations if appropriate

### **TABLES**

1. Chemicals of Concern and Associated Interim Cleanup Levels and AGQS Criteria
2. Site Analytes, Regulatory Standards and Lab Criteria (for all compounds tested on site)
3. Media and Laboratory Requirements (Media, Analysis, Test Methods, Containers/Sample Volume, Preservation & Hold Time)
4. Summary of Quality Assurance Samples (Trip Blanks, Duplicates, Equipment Blanks, MSDS)
5. Monitoring Well Information / Monitoring Location Information
6. Sampling Locations and Methods

### **APPENDIXES**

- A. Changes from Previous SAP – (summarizes the changes made since the last SAP)
- B. Current HWRB Master QAPP
- C. Organizational Chart
- D. Sampling Worksheets
- E. Standard Operating Procedures (SOPs) including set up diagrams. Examples:
  1. Calibration of Field Instruments SOP  
Calibration Log
  2. Chain of Custody SOP  
Chain of Custody Forms
  3. Low Flow Sampling Procedure Using Bladder Pumps SOP  
Low Flow Bladder Pump Diagram  
Well Sampling Worksheet
  4. Decontamination SOP

**APPENDIX G**

**EXAMPLE TABLE OF**

**SITE ANALYTES, REGULATORY STANDARDS & LAB CRITERIA**

## Example Table: Site Analytes, Associated Regulatory Standards and Lab Criteria

### GROUNDWATER

(There should be one Table for each Media: Groundwater, Surface Water, Sediments, etc)

Test Methods / Analytes	ROD Alternative Concentration Levels (ACLs)	NHDES Ambient Groundwater Quality Standards (AGQS) (Env-Or 600)	Lab Reporting Detection Limits (RDLs)	Lab Method Detection Limits (MDLs)
<b>VOC Full List of Analytes for VOCs (NHDES 8260B)</b>	<b>(µg/L)</b>	<b>(µg/L)</b>	<b>(µg/L)</b>	<b>(µg/L)</b>
Site Chemicals of Concern				
Vinyl Chloride	95	2	2	0.232
Benzene	340	5	2	0.29
Trichloromethane (Chloroform)	1505	70	2	0.269
1,1,2-Trichloroethane	3 <sup>(1)</sup>	5	2	0.296
Tetrachloroethylene (Tetrachloroethene, PCE)	57	5	2	0.389
Trichloroethylene (Trichloroethene, TCE)	1500	5	2	0.331
Methyl Ethyl Ketone (2-Butanone, MEK)	8000	4000	10	1.466
Monochlorobenzene (Chlorobenzene)	110	100	2	0.347
Dichloromethane (Methylene Chloride)	12250	5	2	0.198
Toluene	2900	1000	2	0.344
1,1-Dichloroethane	81 <sup>(2)</sup>	81	2	0.24
1,2-Dichloroethane	1800	5	2	0.262
1,1,1-Trichloroethane	200	200	2	0.404
<b>SVOCs by EPA Method 8270</b>				
<b>Extraction Method 3510</b>	<b>(µg/L)</b>	<b>(µg/L)</b>	<b>(µg/L)</b>	<b>(µg/L)</b>
Bis-(2-ethylhexyl)phthalate	6	---	5	3.21
<i>Naphthalene</i>	20	20	10	5.53
<b>Metals by EPA Method 200.7/200.8</b>	<b>(mg/L)</b>	<b>(mg/L)</b>	<b>(mg/L)</b>	<b>(mg/L)</b>
Selenium	0.0026	0.05	0.005	0.00051
Additional Site Analytes				
Arsenic	---	0.01	0.001	0.00018
Lead	---	0.015	0.001	0.00015
Iron	---	---	0.05	0.002
Manganese	---	0.84	0.01	0.0009
<b>Chloride by LACHAT 10-117-07-1-B</b>	---	---	3	0.47
<b>Nitrate by LACHAT 10-107-04-1-C</b>	---	10	0.05	0.002
<b>Sulfate (SO4) by LACHAT 10-511-00-1-A</b>	---	500	1	0.08

Notes:

ACL = Alternate Concentration Limits established in the Record of Decision (ROD)

"---" indicates no standard was available for the analyte.

**APPENDIX H**

**EXAMPLE TABLE OF**

**MEDIA AND LABORATORY REQUIREMENTS**

**(MEDIA, ANALYSIS, TEST METHODS, CONTAINERS/SAMPLE VOLUME,  
PRESERVATION AND HOLD TIME)**



**Example Table of Media and Laboratory Requirements  
(Media, Analysis, Test Methods, Containers/Sample Volume,  
Preservation and Hold Time)**

<b>Analytes</b>	<b>Analytical Method</b>	<b>Containers (Type and Size)</b>	<b>Preservation Requirements <sup>4</sup></b>	<b>Maximum Holding Time</b>
<b>Groundwater Samples</b>				
VOCs	NHDES VOC Full List (NHDES Lab's 8260B)	3-40 mL VOA <sup>(1)</sup>	HCL. 4°C +/- 2°C	14 days
1, 4-Dioxane	8260B	3-40 mL VOA <sup>(1)</sup>	4°C +/- 2°C	14 days
SVOCs	Method 8270 Extraction Method 3510	2-1 Liter Amber glass bottles <sup>(2)</sup>	4°C +/- 2°C	7 days to extract, 40 days to analyze
Total As, Pb, Fe, Mn & Se	EPA Method 200.7 / 200.8	1-500 mL Plastic 150 ml minimum amount	HNO <sub>3</sub>	6 months
Chloride	LACHAT 10-117-07-1-B	1-500 mL Plastic	4°C +/- 2°C	28 days
Nitrate	LACHAT 10-107-04-1-C	150 ml minimum amount		48 hours
Sulfate (SO <sub>4</sub> )	LACHAT 10-511-00-1-A			28 Days
Total Kjeldahl Nitrogen (TKN)	LACHAT 10-107-06-2-E	1-250 mL dark plastic	H <sub>2</sub> SO <sub>4</sub> 4°C +/- 2°C	28 Days
<b>Surface Water Samples</b>				
VOCs	NHDES VOC Full List (NHDES Lab's 8260B)	3-40 mL VOA <sup>(2)</sup>	HCL. 4°C +/- 2°C	14 days
Total As, Pb, Fe, Mn & Se, Hardness	EPA Method 200.7 / 200.8	1-500 mL Plastic 150 ml minimum amount	HNO <sub>3</sub>	6 months
<b>Field Parameters for Low Flow and Surface Water Sampling</b>				
Temperature, ORP, Dissolved oxygen (DO), specific conductivity and pH <sup>(3)</sup>	YSI 600XL or 6820 OR QED MP20 Multi- Parameter Water Quality Meter	N/A	N/A	N/A
Turbidity	Hach 2100P Turbidity Meter	N/A	N/A	N/A
<b>Sediment Sampling</b>				
Total As, Pb, Fe & Se, % Solids	EPA Method 200.7 / 200.8	8 oz plastic	4°C +/- 2°C	6 months
Total Organic Carbon (TOC), % Solids	LLOYD KAHN	1-4 oz glass	4°C +/- 2°C	14 days
<b>Field Parameters for Sediment Samples</b>				
A physical description of the sediment sample				

**Notes:**

- (1) Trip blanks will be included in each cooler containing VOC samples. Trip blanks will include HCL-preserved blanks for Full List VOC samples (2 VOA vials) and unpreserved blanks for 1,4-Dioxane (2 VOA vials) There will be one temperature blank per cooler.
- (2) You must collect a total of 4 bottles for two different samples for phenols (one set of 4 is the sample and a duplicate for the field quality control, the second set of four is the sample and a MS/MSD for the lab's quality control)
- (3) The field parameters for temperature, ORP, DO, specific conductivity and pH for surface waters will be collected in-situ.
- (4) Note that the pH requirement for all acid preserved samples is less than 2 units.

**APPENDIX I**

**EXAMPLE TABLE OF**

**SUMMARY OF QUALITY ASSURANCE SAMPLES**

**TABLE OF SUMMARY OF QUALITY ASSURANCE SAMPLES**

<b>Sampling Media</b>	<b>Associated Sampling Equipment</b>	<b>Sample ID</b>	<b>Designated NOTE to be used on Chain-of-Custody</b>	<b>Analyses</b>
<b>EQUIPMENT BLANK SAMPLES</b>				
Lab provided DI Water (collected prior to sampling)	DI Water	EQUIP BLANK	"DI Water"	VOCs, SVOCs, Total As, Fe, Mn, Se & Pb, TOC
Groundwater	Water level	EQUIP BLANK	Water Level	VOCs, SVOCs, Total As, Fe, Mn, Se & Pb
Surface Water	Filter and syringe set up for dissolved metals samples	EQUIP BLANK	"Metals Filter/Syringe"	Dissolved As, Fe, Mn, Se & Pb
Surface Water	Glass jar or stainless steel sampling container to collect surface water VOCs	EQUIP BLANK	"SW Container"	VOCs
Pore Water	Pore water samplers	EQUIP BLANK	"Pore Water Sampler"	Total As, Fe, Se & Pb
Sediment	Ponar/Eckman dredge, core device, stainless steel bowl and utensils	EQUIP BLANK	"Sediment Equip"	TOCs, Total As, Fe, Se & Pb
<b>DUPLICATE SAMPLES</b>				
Groundwater	Bladder Pump	GIL_HA-5-A DUP	N/A	VOCs, SVOCs, Total As, Fe, Mn, Se & Pb
Groundwater	Bailer	GIL_T-24-1 DUP	N/A	VOCs, Total As, Fe, Mn, Se & Pb
Groundwater	Barcad	GIL_T-12-4 DUP	N/A	VOCs, 1,4-Dioxane, Total As, Fe, Mn, Se & Pb
Surface Water	N/A	GIL_SWSED-2A DUP	N/A	VOCs, Total As, Fe, Mn, Se & Pb, Hardness, Dissolved As, Fe, Mn, Se & Pb, Hardness
Pore Water	N/A	GIL_PORE-2B DUP	N/A	Total As, Fe, Se & Pb
Sediment	N/A	GIL_SED-4 DUP	N/A	TOCs, Total As, Fe, Se & Pb

**TABLE OF SUMMARY OF QUALITY ASSURANCE SAMPLES**

<b>Sampling Media</b>	<b>Associated Sampling Equipment</b>	<b>Sample ID</b>	<b>Designated NOTE to be used on Chain-of-Custody</b>	<b>Analyses</b>
<b>LABORATORY MS/MSD SAMPLES</b>				
Groundwater	Bladder Pump Collect a total of four 1-Liter bottles for SVOCs instead of two (This is separate from any duplicate sample)	GIL_HA-5-B	"MS/MSD"	SVOCs
<b>TRIP BLANK/TEMPERATURE BLANK SAMPLES</b>				
Aqueous VOCs (1 per cooler with aqueous VOCs samples)	N/A	TRIP BLANK	Identify all Sample IDs associated with Trip Blank in notes section of COC	VOCs
Temperature Blank	N/A	TEMP BLANK	Include in notes section of COC that a temperature blank has been included in the cooler	Temperature

**APPENDIX J**

**HAZARDOUS WASTE REMEDIATION BUREAU**

**RECORDS RETENTION POLICY**

## HAZARDOUS WASTE REMEDIATION BUREAU RECORDS RETENTION POLICY

Retention and archiving of records is done in accordance with specific statutory or regulatory requirements (additional guidance is provided in Chapter 6 of the current NHDES QMP located at <http://des.nh.gov/organization/commissioner/pip/publications/co/documents/r-co-06-3.pdf>).

All records of the Federal Sites Superfund program shall be maintained according to the Federal Sites Superfund Record Retention Schedule approved by NHDES, the State Records Manager and the State Archivist in 2004. See Appendix G for a summary of the HWRB Records Retention Policy.

### Superfund Records Retention Policy

Record Description	Retention in Years
Superfund Contract Management Records - Site Specific	30 years after close of contract
Enforcement Actions - Site Specific No legal action required or routine cases	30 years after close of case
Enforcement Actions - Site Specific - Landmark Cases	Permanent
Hazardous Waste Compliance Site Files	Permanent
Grants & Support Agreements (Records not needed for cost recovery)	7 years after closeout of agreement
Grants & Support Agreements (Records needed for cost recovery)	30 years after closeout of agreement
Remedial Site Files - Site Specific	Permanent
Removal Records - Site Specific	Permanent
Sampling & Analytical Data Files - Site Specific	30 Years after major review or when all cost recovery actions are complete
Site Assessment NFRAPs (No further Remedial Action Planned Sites)	40 years after remediation determination
Site Assessment NPL sites	Permanent
Site Assessment Removal action sites	Permanent

All records of the State Sites Remediation Program shall be maintained according to the Draft State Sites Remediation Program Record Retention Schedule. See summary below.

### State Sites Records Retention Policy

Record Description	Retention in Years
Site Remediation Files	100 years after closure of file
Confidential Files	100 years after closure of file

Contractor records shall be maintained for seven (7) years following completion of the project. At the end of the retention period, the Contractor shall offer the records to the State. If the State declines to accept the records, the records become the property of the Contractor.

**APPENDIX K**  
**CROSSWALK BETWEEN HWRB MASTER QAPP**  
**AND EPA REQUIREMENTS**

## Crosswalk between HWRB Master QAPP and USEPA Requirements

USEPA REQUIRED INFORMATION	NHDES QAPP
A1 Title and Approval Page	Title Page and Approval Page
A2 Table of Contents Program Information	Table of Contents (Page1) 1.0 Introduction (Page 6) 1.1 Overview of Hazardous Waste Remediation Bureau (Page 6)
A3 Distribution List Project Personnel Sign-off Sheet	Distribution List (Page 3) Project Personnel Log Sheet (Appendix L)
A4 Project Organizational Chart / Communication Pathways / Personnel Responsibilities & Qualifications A8 Special Training Requirements / Certification	Program Organization and Responsibility, Organizational Chart (Appendix A ) 1.2 Program Organization, Responsibility and Communication Pathways (Page 7) 1.5 Training, Personal Protection and Safety (Page 10)
A5 Project Definition/ Site History and Background Project Planning	Project definition, site description and background information shall be addressed ion site specific SAPs
A6 Project Description	1.0 Introduction (Page 6) 1.3 Project Description (Page 8)
A7 Project Quality Objectives	1.4 Quality Assurance Objectives (Page 8)
B1 Sampling Process Design	Sampling process design is site specific and shall be addressed ion site specific SAPs
B2 Sampling Procedures Cleaning and Decontamination of Equipment/Sample Containers B7 Equipment Calibration B6 Equipment Maintenance, Testing and Inspection Requirements Sampling Container, Volumes and Preservation	Standard Operating Procedures (Appendix C) 2.3 Decontamination (Page 17) 2.4 Instrument Calibration and Maintenance (Page 18) 2.5 Field Screening Instruments (Page 19) 2.7 Sampling Volume, Containers and Labeling (Page 20) 2.8 Sampling Preservation and Holding Times (Page 21)
B3 Sample Handling, Tracking and Custody Requirements Sample Collection Documentation	2.7 Sample Volume, Containers and Labeling (Page 20) 2.9 Chain of Custody Procedures (Page 21) 2.10 Laboratory Sample Management (Page 22) 1.6 Documentation and Records (Page 10)
B4 Analytical Method Requirements Analytical Methods and SOPs B7 Laboratory Instrument Calibration B6 Laboratory Instrument/ Equipment Maintenance, Testing and Inspection B8 Laboratory Inspection and Acceptance for Supplies	1.4 Quality Assurance Objectives (Pages 8-9) Analytical services shall be provided by laboratories which are currently accredited under the National Environmental Laboratory Accreditation Conference (NELAC) standards and have their own quality assurance manual and standard operating procedures (SOPs) that meet the NELAC standards.
B5 Quality Control Requirements	2.11 Sample Quality Control (Page 22)
A9, B10 Documentation, Records and Data Management	1.6 Documentation and Records (Page 10)
C1 Assessments and Response Actions	1.7 Data Assessment (Page 14) 1.8 Corrective Action (Page 15)
C2 QA Management Reports	See Response to B4 above,
D1 Verification and Validation Requirements	See Response to B4 above
D2 Verification and Validation Procedures	See Response to B4 above
D3 Data Usability/Reconciliation with Project Quality Objectives	1.7 Data Assessment (Page 14)



**APPENDIX L**

**HWRB MASTER QAPP PERSONNEL LOG SHEET**

**(Found only in the original QAPP that is kept with the QA Coordinator)**

### QAPP Project Personnel Log Sheet

Project Personnel	Position	Signature	Date
Carl Baxter	Administrator		
John Regan	Supervisor of State Sites Section Hydrogeologist		
Keith DuBois	Brownfields Hydrogeologist		
John Liptak	Supervisor		
Ralph Wickson	Hydrogeologist		
Mike McCluskey	Sanitary Engineer		
Karlee Kenison	Groundwater Remediation Permitting Hydrogeologist		
Rebecca Lawrence	Hydrogeologist		
Elizabeth Stark	Hydrogeologist		
Peter Beblowski	Hydrogeologist		
Richard H. Pease	Supervisor of Federal Sites Section Civil Engineer		
Tom C. Andrews	Sanitary Engineer		
Andrew J. Hoffman	Civil Engineer		
Sharon G. Perkins	QA Coordinator / Environmentalist		
Scott E. Hilton	Hydrogeologist		
Robin Mongeon	Civil Engineer		
Kenneth N. Kettenring	Supervisor of Grants & Contracts Management Section		
Dave Bowen	Hydrogeologist		
Joe Donovan	Environmentalist		
Charles A. Crocetti	Sanborn, Head & Associates		
Michael B. Asselin	GZA Environmental		
Tom Bobowski	Nobis Engineering		
James P. Ricker	Weston		
Michael C. Penney	GeoInsight		
Dave Dedian	Woodard & Curran		

This form must be signed by ALL HWRB Project Managers and project personnel along with the contact person for each contractor approved by NHDES to perform work for the HWRB, to indicate that they have reviewed the HWRB Master QAPP and will implement the QAPP as described.